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Emissions Characterization of Heavy-Duty Diesel and Gasoline Engines and Vehicles

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16. ABSTRACT

Laboratory emissions evaluations were performed on heavy-duty diesel and gasoline engines and vehicles. Results from using water injection (unstabilized macro-emulsion formed in the injection pump) on a heavy-duty diesel engine showed major reductions in particulate and NO_x emissions, except during idle and light load conditions. Emissions of some species of hydrocarbons, aldehydes and the organic fraction of the total particulate increased during idle and light load conditions. Test work carried out on the heavy-duty gasoline engine running at high load confirmed that BaP emissions did exist, but that the levels emitted were low, and that they decreased with leaner f/a ratio. Selected maladjustments (simulating wear of inadequate maintenance) of the Cummins VTB-903 substantially increased HC, smoke and particulate emission levels. Maladjustments of the Detroit Diesel 6V-71N coach engine resulted in lower HC and NO_x emission levels, but higher CO emissions, smoke, and particulate. Emissions over various chassis test cycles from three in-service transit buses proved to be highly variable from one bus to another. In addition, emissions from each bus were very test cycle-sensitive.

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FOREWORD

This report is based on work initiated by EPA Contract No. 68-03-2706, received by Southwest Research Institute on September 20, 1978. This contract was for "Emissions Characterization of Heavy-Duty Diesel and Gasoline Engines and Vehicles." The work was identified within SwRI as Project No. 03-5428-001. The experimental work completed under this contract was performed intermittently from September 20, 1978 to December 20, 1984. Work over this time span included experiments with water injection into a heavy-duty diesel engine to investigate the effect of water injection on emissions, especially particulate emissions. In addition, emissions from a heavy-duty gasoline engine were characterized, primarily for investigating the soluble organic fraction of the particulate emitted by the engine. Emissions from two engines typically used in buses were characterized in both baseline and maladjusted configurations in order to determine their emissions sensitivity to wear or inadequate maintenance (baseline emissions from one of the two engines were determined under Task No. 8 of EPA Contract No. 68-03-2884).

Contract No. 68-03-2706 was to include emissions characterization from an advanced state-of-the-art internal combustion engine. However, no heavy-duty engine was made available, so the remaining technical effort was redirected to obtain emissions information on current design in-service transit buses. Test work on these buses was completed December 20, 1984.

The Project Officer and the Technical Project Monitor for EPA's Technology Assessment Branch during the conduct of this program was Mr. Thomas M. Baines. SwRI Project Director was Mr. Karl J. Springer, and SwRI Project Manager was Mr. Charles T. Hare. The SwRI Project Leader and principal investigator for the effort was Mr. Terry L. Ullman. Lead technical personnel were Mr. Ernest M. Krueger and Mr. Jim Chessher. Over the 6 1/2 years of the program, the entire staff of the Department of Emissions Research participated directly and indirectly. Determinations of some unregulated emissions were conducted by EPA personnel at Research Triangle Park, namely Dr. Ronald L. Bradow, Dr. Frank M. Black, and Dr. Robert Jungers.

We would like to express our appreciation to several engine manufacturers and other companies listed below, for supplying test engines, test apparatus and in some cases, technical direction and assistance.

Mack Trucks, Inc.
American Bosch - now: United Technologies Corporation
Cummins Engines, Inc.
Detroit Diesel Allison Division of General Motors
VIA Metropolitan Transit of San Antonio
Houston Metropolitan Transit Authority

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Emissions measurements included gaseous and particulate components. Regulated pollutants measured were total hydrocarbons, carbon monoxide, oxides of nitrogen, carbon dioxide (as necessary for fuel consumption calculations), visible smoke, and total particulate mass. Unregulated pollutants measured included aldehydes, phenols, some individual (low molecular weight) hydrocarbons, and odor index (DOAS) in exhaust gases. Analysis of particulate matter included sulfate, elemental composition, size distribution, and total organic soluble mass. The solubles were further analyzed by determining boiling range, BaP, and Ames bioactivity.

Results from using water injection (unstabilized macroemulsion formed in the injection pump) showed major reductions in particulate and NO_x emissions, except during idle and light load conditions. Emissions of some species of hydrocarbons, aldehydes and the organic fraction of the total particulate increased during idle and light load conditions. Test work carried out on the heavy-duty gasoline engine running at high load confirmed that BaP emissions did exist, but that the levels emitted were low, and that they decreased with leaner f/a ratio. Selected maladjustments of the Cummins VTB-903 substantially increased HC, smoke and particulate emission levels. Maladjustments of the Detroit Diesel 6V-71N coach engine resulted in lower HC and NO_x emission levels, but higher CO emissions, smoke, and particulate. Emissions from the three in-service transit buses proved to be highly variable from one bus to another. In addition, emissions from each bus were very test cycle-sensitive.

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I. INTRODUCTION

The objective of this work was to gather emissions data pursuant to the larger program needs of the Environmental Protection Agency. Initially, the program was designed to characterize emissions from heavy-duty engines using advanced or novel techniques to reduce emissions. Provisions for testing an advanced engine were also included in the contract. However, no available advanced engine was developed to the point that meaningful emissions data could be obtained. Work reported under this program spans nearly 6 1/2 years, and includes emissions characterization work in four areas.

The first area investigated was the effect of water injection on heavy-duty diesel emissions. The approach studied involved mixing water and fuel within the diesel injection pump and injecting this macroemulsion into the combustion chamber before the water and fuel had time to separate. A second area investigated was the apparent potential for heavy-duty gasoline engines to emit organics such as BaP over certain operating modes. The third area was emissions from heavy-duty engines and how they change with in-service use from the standpoint of wear and/or improper maintenance. The fourth area was emissions from three in-service buses of popular make and model, run on both No. 1 and No. 2 fuels over various test cycles.

In all cases, emissions characterization was the primary task. Over the duration of this program, several of the test procedures and analytical procedures for determining some of the emissions changed. Emissions characterization studies conducted in the first two areas mentioned were based on steady-state operation over various modes of the 1979 13-mode Federal Test Procedure.(1)* Most of the emissions data were obtained from raw exhaust gases, but all particulate-related emissions were obtained using a dilution tunnel operated in a "splitter" mode (only a portion of the engine's exhaust was diluted for the study of particulate emissions). By the time emissions work was begun on the bus engines in both baseline and maladjusted configurations, the 1984 Transient Federal Test Procedure(2) had been established for research purposes, and hence almost all emissions samples were taken from a CVS-diluted exhaust stream. Emissions characterization of the in-service transit buses utilized a truck chassis dynamometer and a large CVS. Emphasis was placed on obtaining emissions over various transient chassis dynamometer test cycles. Results from these four distinct areas are presented in four separate parts of this report, and the summary gives the main findings of each area separately.

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*Numbers in parentheses designate references at the end of the report.

II. SUMMARY

Emissions from heavy-duty diesel and gasoline engines and vehicles were determined on behalf of the Environmental Protection Agency. Over the 6 1/2 year time span of this program, emissions characterization work was performed in four areas. The first area included emissions characterization of a 1977 Mack ETAY(B) 673A heavy-duty diesel engine operated on No. 2 emissions fuel alone, and then with 30 weight percent of water added. Use of a fuel-water macroemulsion had shown reductions in smoke emissions, and was viewed as a potential method to reduce smoke-related particulate emissions along with NO_x emissions.

The 314 hp Mack engine was operated at various steady-state conditions (11 modes of the 13-mode Federal Test Procedure),(1) and emissions were characterized with and without water added to the fuel. Thirteen-mode composite emission results are summarized in Table 1. For the Mack engine, use of the unstabilized fuel-water macroemulsion, formed in the injection pump, caused a 24 percent reduction in NO_x emission with little change in total HC or CO emissions. Use of the macroemulsion increased emissions of selected individual hydrocarbons and aldehydes, primarily during light (2 percent) load and idle operation. Substantial reductions in visible smoke were noted with water addition, and composite total particulate emissions were reduced 54 percent. Reductions in particulate emissions were noted during all operating conditions except light load and idle. At these conditions, using the macroemulsion caused increases in the soluble organic fraction (SOF) of the total particulate, even though the composite SOF level was about the same as the baseline level. Analysis of the SOF for benzo(a)pyrene (BaP) showed 22 percent higher composite levels, mostly due to increased BaP levels at idle, when using the fuel-water macroemulsion. Results from Ames bioassay of the SOF indicated that using the macroemulsion slightly increased the potential for bioactivity (dependent on tester strain used and whether or not metabolic activation was present).

The second area of emission research under this contract was to replicate and expand emission characterization of a 1977 model year Chevrolet 366 cubic inch heavy-duty gasoline engine which had been tested under a previous EPA Contract (68-03-2417). The earlier work had reported relatively high levels of BaP and other emissions during high load operation. The same Chevrolet 366 gasoline engine, operated on leaded fuel, was retested in its "stock" configuration and in a "lean" configuration. Emphasis in this program was placed on obtaining large quantities of particulate for subsequent Ames analysis of the SOF by EPA. The results obtained from the retest of this engine are summarized in Table 2. Upon retest, the gaseous emissions of HC, CO, and NO_x agreed well with those found in the earlier work. Relatively large particulate samples accumulated from engine operation in both configurations were delivered to EPA and Ames analyses were performed on them. Results of their analyses are given in Table 2 for record purposes.

A third set of emission characterization tests were performed to establish how emissions from two heavy-duty transit bus engines change with in-service

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TABLE 1. SUMMARY OF EMISSIONS FROM THE MACK ETAY(B) 673A WITH AND WITHOUT WATER INJECTION

Engine		Mack ETAY(B) 673A	
Test Configuration		Baseline	With Water
Composite		13-Mode	13-Mode
Hydrocarbons, HC g/kW-hr		0.60	0.62
Carbon Monoxide, CO g/kW-hr		1.64	1.75
Oxides of Nitrogen, NO_x[b] g/kW-hr		8.52	6.49
Brake Specific Fuel Consumption kg/kW-hr		0.240	0.239
Total Individual HC mg/kW-hr		83	93
Total Aldehydes mg/kW-hr		49	53
Total Particulate g/kW-hr		0.68	0.31
Sulfate, $SO_4^=$ mg/kW-hr		42	40
Soluble Organic Fraction (SOF) mg/kW-hr		83[a]	81[a]
Benzo(a)pyrene (BaP) μg/kW-hr		0.18[a]	0.22[a]
Ames Response[c] (10^3 rev/plate)/kW-hr	No[d]	12[a]	12[a]
	Yes[d]	13[a]	19[a]

[a] 7-Mode composite
[b] Continuous NO_x
[c] Response on Strain TA98
[d] Metabolic activation status

TABLE 2. SUMMARY OF EMISSIONS FROM THE CHEVROLET 366 HEAVY-DUTY GASOLINE ENGINE

Engine		Chevrolet 366		
Test Configuration		Stock		Lean
Test Condition		2300/100%	2300/50%	2300/100%
Hydrocarbons, HC g/kW-hr		3.80	0.04	--[a]
Carbon Monoxide, CO g/kW-hr		268	15.9	--[a,b]
Oxides of Nitrogen, NO_x g/kW-hr		1.09	2.69	--[a]
Brake Specific Fuel Consumption kg/kW-hr		0.376	0.389	--[a]
Total Particulate g/kW-hr		0.15	0.13	0.11
Soluble Organic Fraction (SOF) mg/kW-hr		3.1	1.5	0.55
Benzo(a)pyrene (BaP) µg/kW-hr		0.16	0.002	0.0003
Ames Response[c] (10^3 rev/plate)/kW-hr	No[d]	14	18	2.2
	Yes[d]	9.4	2.3	0.8

[a] Comparative data not taken

[b] Raw exhaust CO was reduced from 6.0% in "stock" configuration to 0.5% in "lean" configuration

[c] Response on Strain TA100

[d] Metabolic activation status

use from the standpoint of wear and/or improper maintenance. Two heavy-duty diesel transit bus engines, a 1979 Cummins VTB-903 and a 1979 Detroit Diesel (DDAD) 6V-71N, were maladjusted such that noticeable increases in smoke emissions were observed. Emission results from baseline and maladjusted configurations of both engines are summarized in Table 3.

For the Cummins VTB-903 operated on No. 2 emissions diesel fuel, maladjustments consisted of 0.004 inch increase in injector lash and 4 in. Hg reduction in turbocharger boost pressure (at rated conditions). These maladjustments caused the smoke opacities to double from baseline levels. During 13-mode steady-state and transient FTP's,(2) the total HC and CO emissions increased by factors of 4 and 1.6, respectively. Levels of NO_x emissions were essentially unchanged by the maladjustments, but there was a 3 percent loss in maximum power and about a 6 percent increase in cycle BSFC. Individual hydrocarbon emissions of ethylene and propylene during transient FTP operation increased by a factor of 3. Aldehydes (mostly formaldehyde) increased somewhat, and phenols were essentially unchanged. As with the smoke opacities, total particulate on transient FTP operation increased by a factor of 2.1, mostly due to increased particulate emissions at light load conditions. Sulfate levels in the total particulate were generally lower by 13 percent with the maladjustments. Elemental analysis of the total particulate showed that the sulfur level was lower, and that the H/C mole ratio was greater (particulate was more oily) with the maladjustments. Brake specific emissions of the soluble organic fraction of the total particulate increased by about a factor of 3. These results indicate the maladjustments produced no additional elemental carbon matter, but more adsorbed hydrocarbons. Ames response of the SOF indicated an order of magnitude greater bioactivity potential due to the maladjustments.

For the DDAD 6V-71N operated on No. 1 emissions diesel fuel, maladjustments consisted of installation of 50,000 mile injectors, 2.8 degrees retard of injection timing, absence of throttle delay, and 7 in. H_2O increase of intake air restriction. These maladjustments caused smoke opacity to triple. Composite HC emission levels during 13-mode steady-state and transient operation in the maladjusted configuration decreased by 23 and 10 percent from baseline levels, respectively. Emissions of CO increased by factors of 1.8 and 4.4 over steady-state and transient operation in the maladjusted configuration. NO_x emission levels decreased about 25 percent, and the BSFC increased by about 6 percent with maladjustment. There was little change in emission of ethylene or propylene as measured by the IHC procedure. Aldehydes and phenols increased only slightly. Maladjustment increased the total particulate by a factor of almost 2.4. Characterization of the total particulate indicated a decrease in the level of sulfate (32 percent decrease for transient-derived particulate). The H/C mole ratio indicated that the particulate became more carbonaceous (drier) with maladjustment. Determination of brake specific SOF indicated no change in the steady-state composite level, but levels for transient FTP operation decreased by about 28 percent. Therefore, maladjustments to the DDAD 6V-71N produced no additional organics in particulate but rather increased the elemental carbon (soot) which is the opposite of that which occured with the four-stroke cycle Cummins engine. Essentially no BaP was detected for either configuration of this engine. Ames response of the SOF indicated little change in the bioactivity potential due to the maladjustments.

TABLE 3. SUMMARY OF EMISSIONS FROM BASELINE AND MALADJUSTED BUS ENGINES

Engine		Cummins VTB-903				DDAD 6V-71N			
Test Configuration		Baseline		Maladjusted		Baseline		Maladjusted	
Composite		13-Mode	Transient	13-Mode	Transient	13-Mode	Transient	13-Mode	Transient
Hydrocarbons, HC g/kW-hr		0.96	1.79	3.94	6.98	2.37	2.47	1.82	2.18
Carbon Monoxide, CO g/kW-hr		2.20	1.87	3.54	3.12	9.92	5.87	17.83	17.12
Oxides of Nitrogen, NO_x[a] g/kW-hr		9.29	8.48	9.25	7.63	9.60	10.21	6.98	7.52
Brake Specific Fuel Consumption kg/kW-hr		0.254	0.269	0.269	0.288	0.297	0.322	0.316	0.340
Total Individual HC mg/kW-hr		82[d]	103	420[d]	300	150[d]	190	100[d]	200
Total Aldehydes mg/kW-hr		13[d]	100	66[d]	99	29[d]	31	36[d]	44
Total Phenols mg/kW-hr		--[c]	15	--[c]	10	--[c]	58	--[c]	340
Total Particulate g/kW-hr		0.32	0.51	0.57	1.08	0.70[d]	0.72	1.84[d]	1.70
Sulfate, $SO_4^=$ mg/kW-hr		40	38	33	33	25[d]	28	23[d]	19
Soluble Organic Fraction (SOF) mg/kW-hr		130[d]	260	340[d]	830	200[d]	400	200[d]	290
Benzo(a)pyrene (BaP) µg/kW-hr		--[b]	--[b]	--[b]	--[b]	e	e	e	e
Ames Response[c] (10^3 rev/plate)/kW-hr	No[d]	--[b]	160	--[b]	1600	60[d]	160	100[d]	150
	Yes[d]	--[b]	210	--[b]	2700	170[d]	140	110[d]	120

[a] Determined by continuous monitoring
[b] Samples submitted but not processed by EPA
[c] 5-modes only
[d] 7-mode composite
[e] <0.0002 µg BaP/mg SOF

The fourth area of work included determinations of regulated and selected unregulated emissions for three in-service GMC RTS II Type 4 buses. All three late model year buses were powered by DDAD 6V-92TA heavy-duty diesel engines, but varied in mileage accumulated prior to testing and in the diesel fuel type used. All three buses were operated over various test cycles for emissions. Emphasis was given to test work conducted on the transient chassis cycle and the filtered bus cycle. Emission results from all three buses operated on these two test cycles are summarized in Table 4.

Comparison of emissions from these three buses indicates a wide range of variability in exhaust emissions from bus to bus. Emissions varied from bus to bus operated on the same fuel, and they even varied substantially from cycle to cycle run on the same bus. Obviously, some difference in emissions from the individual buses was expected, but not to the extent indicated by the data given in Table 4. Emission levels of total HC (along with selected individual HC), CO, integrated smoke, and particulate were highest for bus 1934, which had the highest mileage of the three buses and operated on No. 1 diesel fuel. Bus 2162, with the lowest mileage and operated on No. 2 diesel fuel, had the highest levels of NO_x, sulfate (higher level of fuel-bound sulfur), and soluble organic emissions of the three buses. Both bus 1934 and bus 2162 had high oil consumption compared to bus 2126. Bus 2126 had the highest level of aldehyde emissions, and appeared to be least cycle-sensitive of the three buses. From the data given in Table 4, it appears that a larger sample of in-service buses would be necessary to isolate the causes of emissions variability, or to assess the average emissions from a nationwide fleet of similar design.

Publications

A major portion of the work conducted under this contract has been reported in technical papers. The work with fuel-water macroemulsion has been presented in ASME 80-DGP-42.(3) Work with the maladjusted bus engines has been reported in SAE 840416.(4) A technical paper on the emission results obtained from the three in-service buses is planned.

TABLE 4. SUMMARY OF EMISSIONS FROM THREE GMC RTS II TYPE 4 BUSES POWERED BY DDAD 6V-92TA HEAVY-DUTY ENGINES EMISSIONS TEST PROCEDURE

Bus No. (Fuel Type) (Service, km) Oil Use, km/ℓ	2162 (No. 2) (88,617) 764		2126 (No. 1) (160,698) 1142		1934 (No. 1) (223,340) 707	
Chassis Test Procedure	Transient[a]	Filtered Bus[b]	Transient[a]	Filtered Bus[b]	Transient[a]	Filtered Bus[b]
Hydrocarbons, HC g/kg fuel	1.82	3.39	3.12	4.89	4.35	7.62
Carbon Monoxide, CO g/kg fuel	18.00	7.26	9.82	7.94	19.92	15.04
Oxides of Nitrogen, NO_x[c] g/kg fuel	36.86	43.90	32.53	38.99	24.86	31.47
Fuel Economy km/kg fuel	2.48	2.32	2.74	2.52	2.56	2.43
Total Individual HC mg/kg fuel	140	150	130	170	370	650
Total Aldehydes mg/kg fuel	410	610	680	610	350	480
Integrated Smoke % Opacity	2.9	2.0	2.2	1.8	4.2	2.5
Total Particulate g/kg fuel	3.95	2.39	2.73	2.16	6.14	5.17
Sulfate, $SO_4^=$ mg/kg fuel	220	130	58	44	67	64
Soluble Organic Fraction (SOF) mg/kg fuel	930	800	670	500	710	270

[a] Transient composite of cold- and hot-start chassis testing
[b] Experimental bus cycle filtered to approximate bus operation
[c] Continuous NO_x

III. EMISSIONS CHARACTERIZATION OF THE MACK ETAY(B) 673A HEAVY-DUTY DIESEL ENGINE WITH AND WITHOUT WATER INJECTION

This section of the report describes the experimental set-up and the Mack engine tested for emissions characterization with and without water injection. General test notes are given to explain the methods used for engine testing, along with the procedures used to obtain and process various emissions samples. The third portion of this section presents the emissions results obtained. Detailed supporting data are given in Appendix A.

A. Test Engine Description

A 1977 Mack ETAY(B) 673A heavy-duty diesel engine was selected for use in this program. At the time this engine was chosen, American Bosch (now a division of United Technologies Corp.) had been working with Mack Trucks Inc. on the development of a Universal Fuel Injection System (UFIS). The UFIS system was expected to represent a state-of-the-art fuel system capable of providing good performance and good BSFC along with low emissions of particulate and smoke. Another concept from American Bosch for particulate control included injection of a fuel-water emulsion formed at the injection pump of the engine and injected into the combustion chamber as a macroemulsion. Both concepts were readily adaptable to the Mack ETAY(B) 673A engine, and the engine had been used in support of another EPA contract performed by SwRI to investigate the effect of high pressure fuel injection on emissions.(5)

The 1977 Mack ETAY(B) 673A was a turbocharged, aftercooled, in-line 6-cylinder engine with a displacement of 673 cubic inches and a compression ratio of 15:1. This engine utilized a tip-turbine-powered intercooler which operated by bleeding off a portion of the compressed intake air to drive a cooling fan, which in turn cooled the hot compressed intake air charge before it reached the intake manifold. Figure 1 shows the engine mounted for dynamometer test work. During steady-state operation with the standard American Bosch fuel injection pump (APE pump), a maximum power of 314 hp (234 kW) was observed at the rated speed of 1900 rpm with 123 lb/hr of No. 2 fuel. A maximum torque of 1026 ft-lb was observed at an intermediate speed of 1450 with 102 lb/hr of No. 2 fuel. Curb idle speed was 650 rpm. The fuel used in this phase of the program was Gulf No. 2 doped to 0.24 percent sulfur to approximate the 1978 "National Average" fuel. Some of the properties of this fuel are given in Table 5.

Based on availability of experimental injection pump equipment, experiments with macroemulsion of fuel and water were conducted first. Due to scheduling and proprietary concerns, the UFIS system was never made available for testing under this program.

A new, calibrated stock American Bosch APE pump and set of injectors were installed and the injection timing set to 21°BTDC (standard timing). Water was regulated through a flowmeter, filtered through a 7 mm sintered metal in-line filter, and fed directly to the injection pump. No fuel/water emulsifier was used since mixing was accomplished by the mechanical action of the pump. Nozzle leak-off was fed directly back to the pump. Figure 2 shows the fuel system schematic for fuel-water emulsion testing. This particular pump had no torque-limiting cam in order to allow the pump to handle the extra volume of fuel and water mix (30 lbs of water per 100 lbs of fuel or 30 percent mass). De-ionized water was supplied for water injection. Figure 3 shows the working chart for setting the water flow rate for various fuel requirements to provide 30 percent by mass of water to the injection pump. All modal operation was run by adjusting speed and fuel rate to be identical with the runs made without water. Torque was allowed to vary accordingly. The addition of water seemed to have no effect on the observed power for a given fuel rate. No unusual noises or vibrations were noted during operation with water injection.

B. General Test Notes

The engine configuration for macroemulsion experiments was such that the engine could be operated with or without water addition, thereby obtaining comparative emission samples or measurements. The 1974-1978 and the 1979 13-mode Federal Test Procedures (FTP) were the basic test cycles used for the regulated emissions characterization during this program.(1,6) Both procedures start with low idle, then 2, 25, 50, 75, and 100 percent load at intermediate speed followed by low idle, than to rated speed--100, 75,50, 25, and 2 percent of full load followed by a final low idle condition. Intake air and fuel are measured during each mode. Unregulated emissions characterizations were similarly performed, but only for 11 and 7 modes of steady-state operation (idle mode was only run once instead of three times as with the FTP).

FTP weighting factors formed the basis for the calculations to determine cycle composite emission rates and cycle weighted fuel consumption from modal data. Variations of the basic FTP weighting factors were used to express nonregulated emissions in consistent units; namely, grams per kilowatt hour for those experiments in which 11 and 7 modes were sampled. The basically linear nature of diesel engines emissions with power output makes such an approach feasible. As the number of modes decreases, each modal point represents more time in mode and a wider range of power; thus the weighting for each mode must be increased to reflect the greater significance. Detailed discussion of these various weighting factors can be found in Reference 5.

The test procedures and analytical systems used for each category of emission measurement are described in the following paragraphs. All particulate-related emissions were determined by sampling dilute exhaust, whereas gaseous emissions were measured by sampling raw exhaust. Instruments, sampling, and analysis conformed to Federal Test Procedure where applicable. Nonregulated emissions were analyzed using methodologies established during other work.

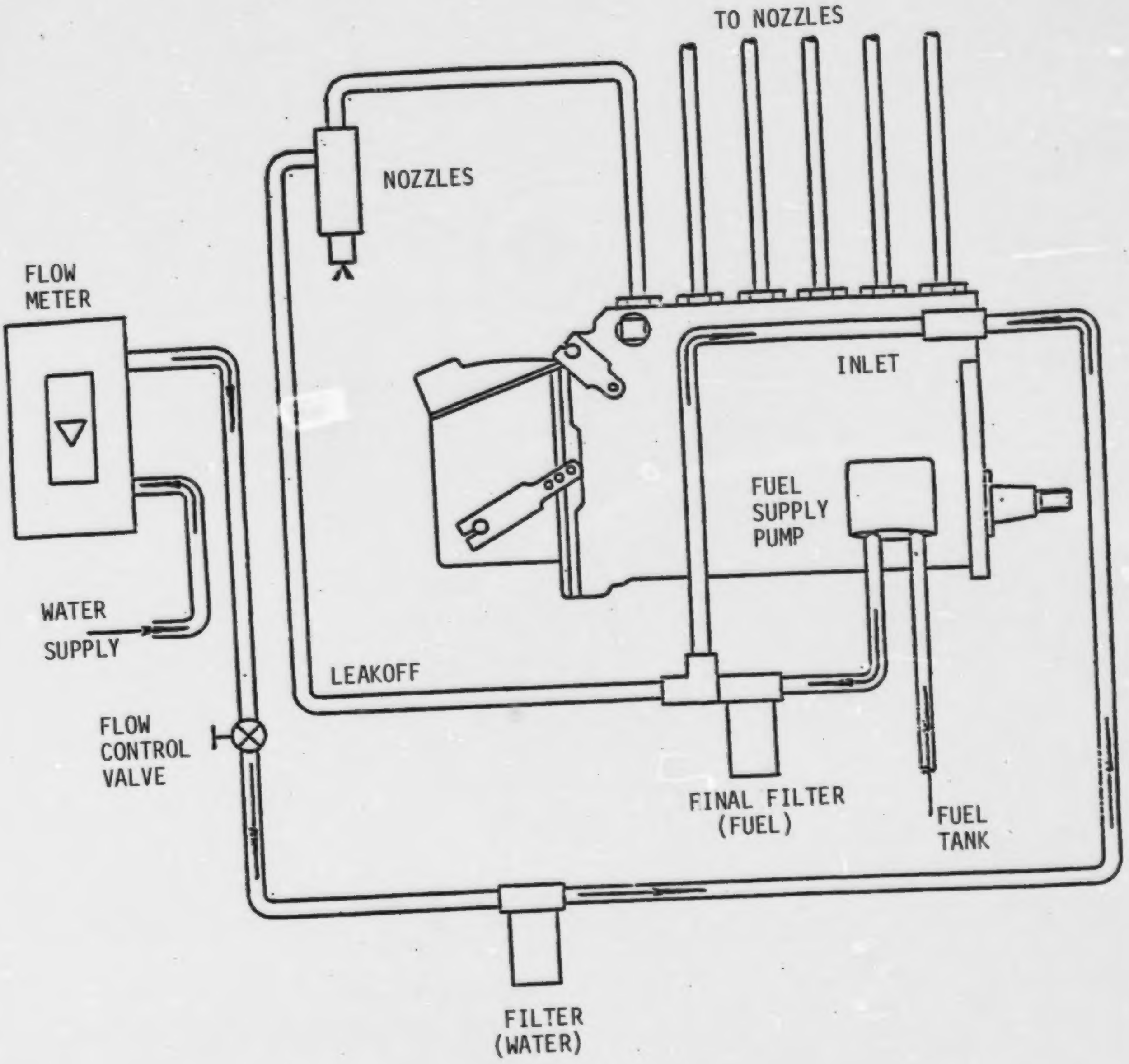
TO NOZZLES
NOZZLES
FLOW
METER
INLET
FUEL
SUPPLY
PUMP
WATER
SUPPLY
LEAKOFF
FLOW
CONTROL
VALVE
FINAL FILTER
(FUEL)
FUEL
TANK
FILTER
(WATER)

Figure 2. Schematic for fuel-water emulsion testing(7)

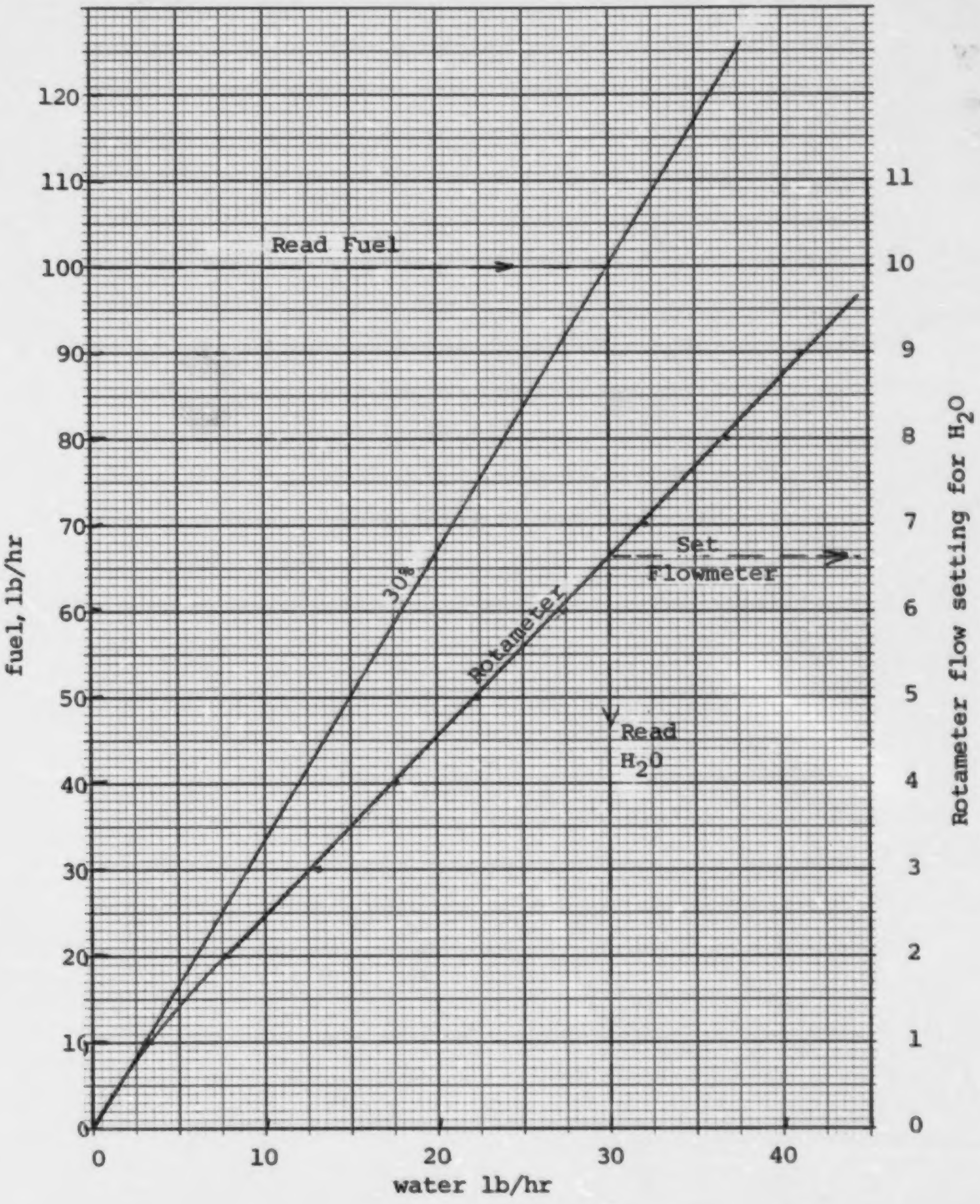

Figure 3. Water injection fuel system chart Mack ETAY(B) 673A

Regulated emissions of HC, CO, and NO (expressed ad NO_2) were measured as specified by the 1974-1978 13-mode FTP.(6) That is, total hydrocarbons were measured by a heated flame ionization detector (HFID). Carbon monoxide and nitric oxide (NO) were measured by non-dispersive infrared (NDIR) detectors. These regulated emissions were also determined by the 1979 13-mode FTP, the main difference being that oxides of nitrogen (NO_x) was determined by NO_x chemiluminescence techniques.(1)

Selected individual hydrocarbons were determined using a gas chromatograph procedure developed by EPA-RTP and described in Reference 8. Seven modes of the basic 13-mode test procedure were sampled (intermediate speed at 2, 50, and 100 percent load, idle, and then rated speed at 100, 50, and 2 percent load). A raw exhaust sample from each mode was filtered and collected in a Tedlar bag, then injected into a gas chromatograph utilizing a single flame ionization detector with a multiple column arrangement and dual gas sampling valves. The timed sequence selection valves allowed the baseline separation of air, methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene. Propylene, ethylene, and toluene react easily in the atmosphere to form photochemical smog.

Aldehydes were measured using the 2,4-dinitrophenylhydrazine (DNPH) method.(8) Basically the procedure, used during each of the 7 modes tested, consisted of bubbling prefiltered raw exhaust through glass impinger traps containing a solution of DNPH and HCl kept at 0°C. Following collection, several intermediate steps are taken to prepare the sample for analysis by gas chromatograph and separation of various aldehydes from formaldehyde to benzaldehyde.

The Coordinating Research Council Diesel Odor Analytical System (DOAS) was used to quantify the total intensity of aroma, (TIA), from 7 of the 11 modes of operation. Raw exhaust was drawn off through a heated sample train and into a trap containing Chromosorb 102. The sample was later eluted and injected by syringe into the DOAS instrument, which is a liquid chromatograph that separates and oxygenate fraction. A.D. Little, the developer of the DOAS instrument, has related this fraction to TIA sensory measurements by the A.D. Little odor panel.(9)

Particulate-related emissions were determined from dilute exhaust samples utilizing various collection media and apparatus, depending on the analysis to be performed. Particulate had been defined as any material collected on Type A glass fiber media at or below a temperature of 51.7°C (125°F) excluding condensed water. The test methodology proposed in the later diesel particulate standards specifies fluorocarbon coated glass fiber media for particulate sampling. Particulate emissions were determined for both configurations by using fluorocarbon-coated glass-fiber filter media in place of the glass fiber filter media.

The 125°F temperature limit and the absence of condensed water dictates that the raw exhaust be diluted. In most cases, this dilution averaged about 12 parts of prefiltered air to one part of exhaust. A dilution tunnel was used to provide mixing and residence time (2 sec) to roughly approximate the minimum time before exposure in traffic.

Large volumes of hot exhaust from heavy-duty diesel engines preclude the practical dilution of all the exhaust in a laboratory size dilution tunnel, hence a relatively small amount of the total exhaust was "split" from the main exhaust flow and diverted to the dilution tunnel. The remainder was vented to atmosphere. A "muffler splitter" method was considered to be a representative way to obtain a portion of the total exhaust. All testing was done using steady-state operating modes which precluded problems of proportional sampling. Figure 4 shows the dilution tunnel system used to measure all particulate-related emissions.

Gravimetric weight gain on the fluorocarbon-coated glass fiber media, representing collected particulate, was determined to the nearest microgram after the filter temperature and humidity was stabilized. This weight gain along with 1) flow measurements from totalizing gas meters, 2) dilution tunnel parameters, and 3) engine flow rates, were used to calculate the particulate mass emissions of the engine at a given operating mode.

Carbon and hydrogen weight percentages in the diesel particulate collected on glass fiber media were measured using ASTM method D-3178, and nitrogen was measured using ASTM method D-3179. Values of H and C content were also expressed in terms of a H/C mole ratio which can be used to compare various engine configurations. As the ratio becomes larger, a more oily nature of the particulate is indicated, whereas lower ratios imply a drier or more carbonaceous type particulate.

Sulfate content of particulate matter was determined from samples collected on 47 mm Fluoropore (Millipore Corp.) fluorocarbon membrane filter media with 0.5 micron pore size. The barium chloranilate analytical (BCA)(10) method was used to determine the amount of sulfate contained on the filter samples. Therefore, "sulfate" should be understood to mean $SO_4^=$ as measured by the BCA method.

Trace metals and other elements such as silicon, sulfur, and calcium in the particulate matter were determined by X-ray fluorescence from samples collected on 47 mm Fluoropore filter media. These samples were collected over 7 modes. This analysis was conducted at the EPA, ORD laboratories in Research Triangle Park, N.C.

Organic solubles and benzo(a)pyrene (BaP) concentration of the particulate were determined for 7 modes of operation for each engine configuration. Due to the analytical procedures used, relatively large samples were required (on the order of 20 to 40 mg of particulate). These larger samples were taken by use of a modified ambient air sampler (HiVol) which used a 203 x 254 mm (8 x 10 inch) Type A glass fiber filter. During collection of these samples, the HiVol system was used in the dilution tunnel instead of the multiple sample probe used to collect the four 47 mm filter samples simultaneously (two Fluoropore, two glass fiber).

The weight of organics extracted from the particulate-laden filter are reported as a percent of the particulate loading of that filter. The extract was carried through the Sawicki analysis procedure for determination of BaP. This procedure involved sample spotting on thin layer chromatographic plates which

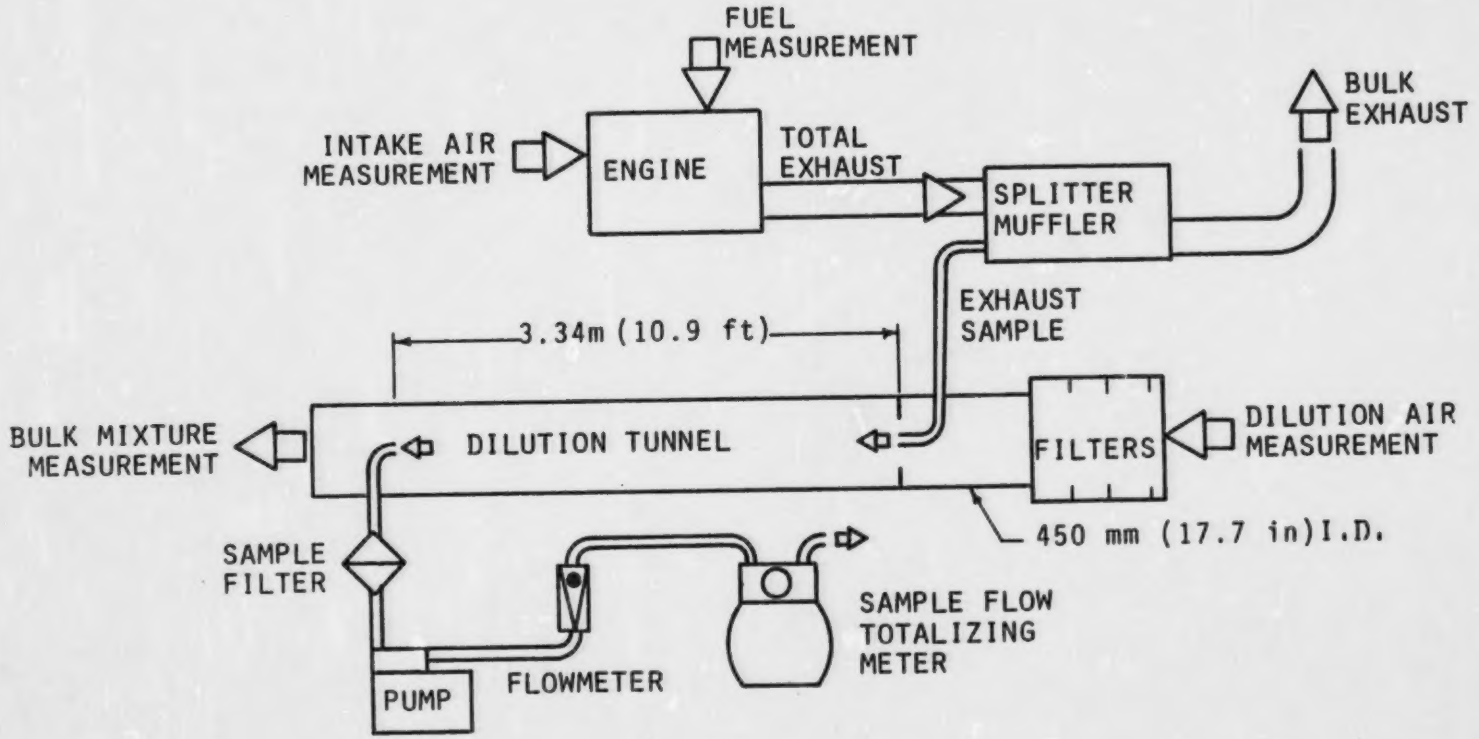
FUEL MEASUREMENT
INTAKE AIR MEASUREMENT
ENGINE
TOTAL EXHAUST
SPLITTER MUFFLER
BULK EXHAUST
EXHAUST SAMPLE
3.34m (10.9 ft)
BULK MIXTURE MEASUREMENT
DILUTION TUNNEL
FILTERS
DILUTION AIR MEASUREMENT
450 mm (17.7 in)I.D.
SAMPLE FILTER
SAMPLE FLOW TOTALIZING METER
PUMP
FLOWMETER

Figure 4. Splitter type dilution tunnel system for particulate

were subsequently scanned by a fluorescence spectrophotometer. BaP is considered to be an elementary indicator of the relative polynuclear aromatic (PNA) levels typically found in diesel exhaust.

The methods for determining organic extractables and BaP content in diesel exhaust were still being developed during this work, and are therefore somewhat imprecise, especially when compared to the relatively precise methods used for regulated emissions. The role of carbon in the exhaust, the effects on organics by filtering the exhaust, and the type of solvent used in the preparation of the sample were all unresolved issued in the collection and determination of BaP. Extraction of organics and determination of BaP content were conducted by EMSL of EPA-RTP.(11) A portion of the extract was also submitted for Ames bioassay through EPA.(12)

Particle size distributions were determined for each engine configuration by use of an Anderson Model 50-810 inertial impactor. Isokinetically sampled dilute exhaust containing a mixture of particle shapes and densities was fractionated, and particles were collected according to their aerodynamic characteristics. The aerodynamic size gives information relating to the physical size, shape and density of the particulate, indicating how the particle may behave in the environment. Pre-weighed stainless steel impactor discs were used for stage collection, and a pre-weighed glass fiber filter was used as a back-up filter to collect all particulate aerodynamically smaller than the lowest cut-off stage (0.42 microns Effective Cut-Of Diameter, ECD). Impactor flowrate was selected to provide individual stage separation from 10.9 to 0.42 microns ECD. Unfortunately, the inertial impactor only sized about 15 percent of the particulate sample. The remaining 85 percent was trapped by the back-up filter which collected everything less than 0.42 micron ECD. On the average, 93 percent of the particulate was below one micron, which leads to the conclusion that diesel particulate is easily respirable. Visible smoke was determined by the end-of-stack EPA-PHS smokemeter, which monitored the opacity of the raw exhaust plume as it issued from the exhaust pipe.

C. Results

Initial test work centered on obtaining 13-mode emission results. During the time when these experiments were being conducted, both the 1974 and the 1979 13-mode FTP were being used. Table 6 gives the gaseous emission results calculated using the 1974 FTP calculations method. Reduced copies of the computer printout are given as Tables A-1 and A-2 in Appendix A. A significant reduction of $BSNO_x$ occurred (24 percent) from operation with water, although slight increases in BSHC and BSCO were noted. There was no change in the BSFC. The engine was run by fuel rate and speed; no change in load was observed with water addition.

Results from the 1979 FTP for the 13-mode gaseous emission tests run with and without water on the Mack ETAY(B) 673A with APE pump are given in Table 7. Reduced copies of the computer printouts are given as Tables A-3 and A-4 in Appendix A. These results were about 15% lower than those using the 1974 FTP, because the 1979 FTP method of calculation is very different from the 1974 FTP method. In addition, measurements included CO_2 by NDIR and NO_x by CL. The trends of lower NO_x, and slightly higher HC and CO, when run with water addition, were the same as for the 1974 FTP, despite the differences in the nominal values of the emissions.

TABLE 6. 1974 13-MODE FTP RESULTS FROM THE MACK ETAY(B) 673A RUN WITH AND WITHOUT WATER ADDITION

Result	Without Water Addition	With Water Addition	Percent Change
BSHC	0.707 g/kW-hr	0.743 g/kW-hr	+5%
BSCO	1.924 g/kW-hr	2.118 g/kW-hr	+10%
$BSNO_x$	9.875 g/kW-hr	7.499 g/kW-hr	-24%
BSFC	0.241 kg/kW-hr	0.241 kg/kW-hr	0%

TABLE 7. 1979 13-MODE FTP RESULTS FROM THE MACK ETAY(B) 673A RUN WITH AND WITHOUT WATER ADDITION

Result	Without Water Addition	With Water Addition	Percent Change
BSHC	0.603 g/kW-hr	0.620 g/kW-hr	+3%
BSCO	1.638 g/kW-hr	1.749 g/kW-hr	+7%
$BSNO_x$	8.518 g/kW-hr	6.494 g/kW-hr	-24%
BSFC	0.240 kg/kW-hr	0.239 kg/kW-hr	0%

Aldehydes were determined for 7 modes by the DNPH method. Composite aldehyde rates for the individual species are given in Table 8 for both runs, without and with water addition. Although there was little change in the total aldehydes, it may be noted that a larger variety of aldehydes were measured during runs with water addition. These other species of aldehydes were generated primarily at 2 percent load, rated and intermediate speed, and at idle during runs made with water addition. Modal results for the aldehydes are given as Tables A-5 and A-6 of Appendix A.

TABLE 8. BRAKE AND FUEL SPECIFIC ALDEHYDE RATES, MACK ETAY(B) 673A WITH APE PUMP

	Without Water		With Water	
Aldehyde	mg/kW-hr	mg/kg fuel	mg/kW-hr	mg/kg fuel
Formaldehyde	19.44	78.81	23.95	98.43
Acetaldehyde	2.06	8.36	7.35	30.24
Acetone	0	0	0	0
Isobutyraldehyde	0	0	1.05	4.31
Crotonaldehyde	24.75	100.35	1.55	6.36
Hexanaldehyde	2.31	9.37	5.51	22.69
Benzaldehyde	0	0	13.96	57.41
Total Aldehydes	48.56	196.89	53.37	219.44

Table 9 summarizes 7-mode composites of the specific hydrocarbons found during comparative runs. Similar to the aldehyde results, water addition significantly increased the emissions of some species, primarily during 2 percent load modes and at idle. The overall total of specific hydrocarbons was slightly higher when water was added. Modal results for specific hydrocarbons are given in Tables A-7 and A-8 of Appendix A.

TABLE 9. BRAKE AND FUEL SPECIFIC HYDROCARBON RATES MACK ETAY(B) 673A WITH APE PUMP

	Without Water		With Water	
Hydrocarbon	mg/kW-hr	mg/kg fuel	mg/kW-hr	mg/kg fuel
Methane	7.06	28.62	11.45	47.09
Ethylene	50.81	206.04	57.60	236.95
Ethane	0.17	0.70	0.38	1.56
Acetylene	4.89	19.85	5.11	21.04
Propane	0.02	0.08	0	0
Propylene	20.46	82.97	18.18	74.78
Benzene[a]				
Toluene[a]				
Total Hydrocarbons	83.41	320.26	92.72	381.42

[a] Could not be determined from chromatogram, fuel interference suspected

Brake and fuel specific rates for benzene and toluene were not obtained because of interferences from unknown chemical species contained in several of the bag samples. The unknown chemical species eluted broadly in the retention time region of benzene and toluene, making it impractical to determine their respective concentrations. A sample bag prepared with a trace of the fuel used in the engine, diluted with zero air, presented a chromatograph with characteristics similar to those found with the unknown chemical species.

Total intensity of aroma (TIA) was determined using the Diesel Odor Analysis System (DOAS) as described earlier. In order to calculate the TIA, liquid chromatographic aldehydes (LCA) and liquid chromatographic oxygenates (LCO) were determined. The DOAS results are given in Table 10. The average TIA values were 1.73 and 1.81 for 7 modes run without and with water addition, respectively. The most significant change occurred at idle, where TIA increased from 1.6 to 2.0 with addition of water.

TABLE 10. DOAS RESULTS FOR MACK ETAY(B) 673A WITH APE PUMP

Configuration	DOAS[a]	1450 rpm 2	1450 rpm 50	1450 rpm 100	Idle	1900 rpm 100	1900 rpm 50	1900 rpm 2
Without Water	LCA	19.0	21.8	3.3	7.1	3.1	12.6	23.4
	LCO	5.8	8.8	2.1	4.3	3.4	7.5	11.0
	TIA	1.8	2.0	1.3	1.6	1.5	1.9	2.0
With Water	LCA	15.6	12.7	4.2	24.3	7.6	11.8	18.8
	LCO	7.9	4.8	3.4	14.3	6.5	5.8	10.0
	TIA	1.9	1.7	1.5	2.0	1.8	1.8	2.0

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[a] LCA and LCO in µg/liter

Use of the fuel-water macroemulsion was expected to reduce smoke and particulate on the basis of preliminary work carried out by American Bosch and Mack Trucks, Inc. The PHS smokemeter was attached to the end of the exhaust stack of the Mack ETAY(B) 673A engine for modal and power curve smoke measurements. The smoke FTP was not run in either configuration due to requirements for manual control of water addition. Results from modal and power curve smoke are given in Table 11. The effect of water injection on smoke opacity was very significant. The reduction in smoke was somewhat greater than 50%, especially during typically high smoke modes (maximum power and full load/intermediate speed).

TABLE 11. SMOKE OPACITY RESULTS FROM MACK ETAY(B) 673A (APE PUMP) WITH AND WITHOUT WATER ADDITION

Mode	Engine Speed,rpm	Load,%	Fuel Rate lb/hr	Smoke Opacity,%	+	Water Rate lb/hr	Smoke Opacity,%
1	650	Idle	2.2	0.5	+	0.8	0.3
2	1450	2	9.8	0.6	+	3.0	0.5
3	1450	25	28.5	1.5	+	8.5	0.7
4	1450	50	50.9	2.9	+	15.5	1.0
5	1450	75	75.2	5.2	+	22.5	1.8
6	1450	100	102.3	6.2	+	30.5	2.9
7	650	Idle	2.3	0.5	+	0.8	0.3
8	1900	100	122.6	4.7	+	36.7	1.6
9	1900	75	90.1	3.0	+	27.0	1.6
10	1900	50	62.7	2.8	+	18.8	1.4
11	1900	25	36.9	2.2	+	11.0	1.0
12	1900	2	15.5	0.4	+	4.5	0.1
13	650	Idle	2.3	0.5	+	0.8	0
			- Power Curve -				
	1900	100	122.9	4.5	+	36.7	1.6
	1700	100	114.0	4.9	+	33.9	2.5
	1300	100	104.8	6.0	+	31.5	4.3
	1450	100	102.5	6.2	+	28.0	4.3
	1300	100	93.5	10.0	+	28.0	4.3

Particulate samples, using the splitter tunnel system, were taken on fluorocarbon-coated glass fiber media, namely Pallflex T60A20. Samples were taken on Fluoropore filter media for sulfate and metals analysis. Particulate samples for C, H, and N were taken on glass fiber filter media to avoid interference problems associated with combusting the fluorocarbon coating on the Pallflex filter media.

At the time this program was conducted, there were some reservations concerning the use of Pallflex particulate filter media. Variable rates of "plugging" for a given filter loading had been experienced on other programs using Pallflex media for particulate characterization. Manufacturing variability from batch to batch had occurred, resulting in filter media of different appearance and density per unit area. An unofficial report of high background organics from the soxhlet extraction procedure was also mentioned. The glass fiber media typically collected more "particulate" of an organic nature than did the Pallflex media. This was expected to cause some difficulty in relating the results of C, H, and N analysis by glass fiber to the potentially lower particulate rates determined by the Pallflex media. This problem had little impact on C, H, and N results and corrections developed were negligible with respect to the overall accuracy of C, H, and N determinations. Concerns over the variability of the Pallflex media were resolved by quality control measures incorporated by the manufacturer. These measures also stabilized and reduced the levels of background organics to acceptable levels. With resolution of these two problems, particulate emissions were determined by use of the fluorocarbon-coated glass fiber media (Pallflex T60A20) to be consistent with the definition of particulate.

Total particulate and sulfate emissions are summarized on a 13-mode composite basis in Table 12. These data were compiled from replicate determinations of emissions from individual modes. The modal data are given in Tables A-9 through Table A-12 of Appendix A. Plots of these average modal data for particulate and sulfate emissions are given in Figures 5 and 6, respectively. Thirteen-mode composite rates were computed as shown in Tables A-13 through A-16 of Appendix A.

TABLE 12. SUMMARY OF TOTAL PARTICULATE AND SULFATE EMISSION RATES FROM THE MACK ETAY(B) 673A WITH APE PUMP

Engine Configuration	Run No.	Brake Specific Particulate g/kW-hr	Brake Specific Sulfate[a] mg/kW-hr	Fuel Specific Particulate g/kg fuel	Fuel Specific Sulfate[a] mg/kg fuel
Without Water	1	0.693	41.79	2.830	170.66
	2	0.677	42.69	2.758	174.59
	Avg	0.685	42.24	2.799	172.62
With Water	1	0.306	38.62	1.266	159.97
	2	0.314	41.18	1.299	170.41
	Avg	0.310	39.90	1.282	165.19

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[a] Fuel used-SwRI EM-329-F (Gulf No. 2 diesel fuel doped to 0.235 wt. % sulfur) "National Average"

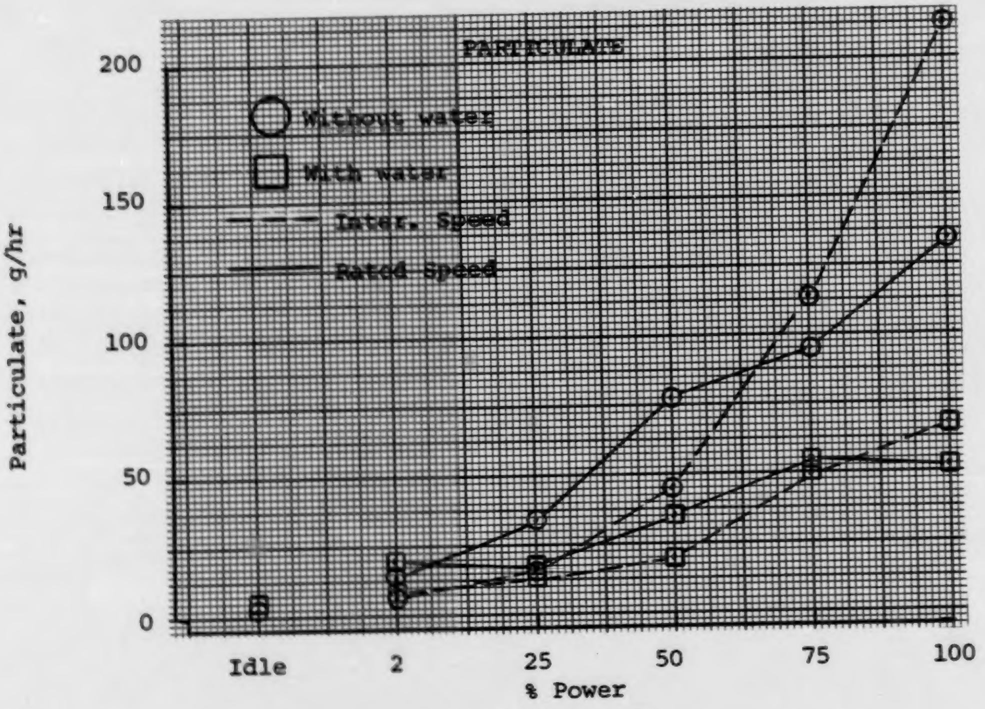

Figure 5. Particulate modal rates for Mack ETAY(B) 673A with APE pump, run with and without water

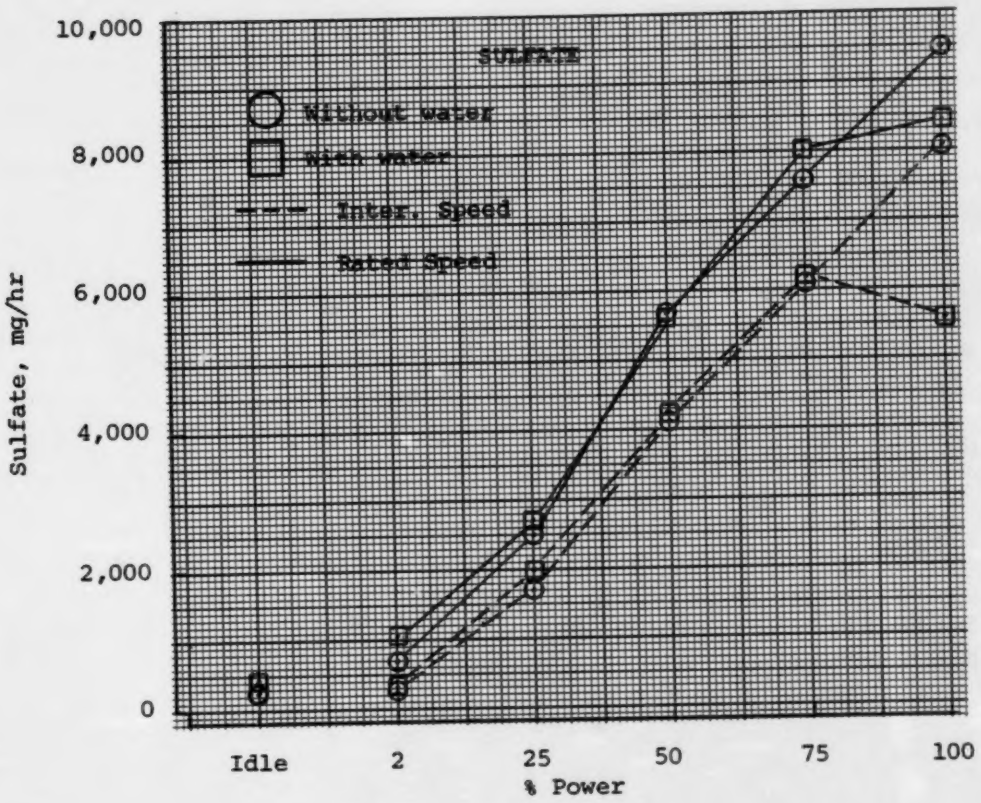

Figure 6. Sulfate modal rates for Mack ETAY(B) 673A with APE pump, run with and without water

On the basis of composite particulate rates, water addition reduced particulate by 55 percent. Major reductions in particulate emissions were noted over the higher-loaded modes when water was added. However, some increases in particulate emissions were noted over the light load (2 percent load) condition and during idle when water was added. Particulate filters from idle and the 2 percent load condition appeared to have less carbonaeous material on them when water was used, but they also appeared to have collected more oily or unburned fuel-like material.

Use of the fuel-water macroemulsion appeared to have little effect on 13-mode composite sulfate emissions, although the level was slightly lower (5.5 percent lower) when water was used. On a modal basis, as illustrated in Figure 6, small increases in sulfate emission rates occurred over idle and the light load conditions. To the contrary, at the full load conditions, significantly lower levels of sulfate emissions were observed with water addition. Over the 11 modes tested (idle run only once), the percent of fuel sulfur converted to sulfate increased slightly (from 2.24 percent to 2.40 percent) when the engine was operated on the fuel-water macroemulsion.

Particle sizing by Anderson Impactor was conducted for five modes during engine operation without and with water addition, and the results are plotted on a modal basis in Figures 7 and 8, respectively. Recall that the size distribution plots are "anchored" by the back-up filter. Pallflex filter media was used as the final or back-up filter during these impactor experiments. Approximately 76 to 91 percent of the collected material was smaller than 0.42 micron Effective Cutoff Diameter (ECD) during runs without water. With the addition of water, 80 to 96 percent of the collected material was smaller than 0.42 micron ECD. The idle mode run with water showed the most significant shift to smaller particle sizes. Overall, no major change in particle size was caused by water addition. Table A-17 of Appendix A shows the percentage plate deposition per stage for the two operating parameters.

As mentioned earlier, there were some reservations on the use of the Pallflex media for collecting total particulate samples. Hence, particulate samples for the determination of C, H, and N content of the total particulate were taken on both glass fiber and fluorocarbon-coated filter media. Preliminary samples for C, H, and N analysis were sent to Galbraith Laboratories to determine whether of not the fluorocarbon-coated glass fiber media could be used in this analysis. Galbraith reported, via Ms. Gail Hutchins, that the fluorocarbon binder used in the Pallflex media produced from 6 to 7 percent, by weight, background carbon reading from a clean blank filter. Since this percentage was significant relative to typical values obtained from particulate-laden filters, it was decided that the fluorocarbon-coated glass fiber media could not be used for C, H, and N analysis. Particulate samples collected on glass fiber media were used for this analysis.

Results from C, H, and N analysis of total particulate samples are given in Table 13, along with computed H/C mole ratios for the total particulate. With exception of the light load conditions, the percent of carbon increased with use of the fuel-water macroemulsion, whereas the percent of hydrogen tended to decrease. The H/C mole ratio increased for the light load conditions, indicating that the particulate was slightly more oily with the macroemulsion

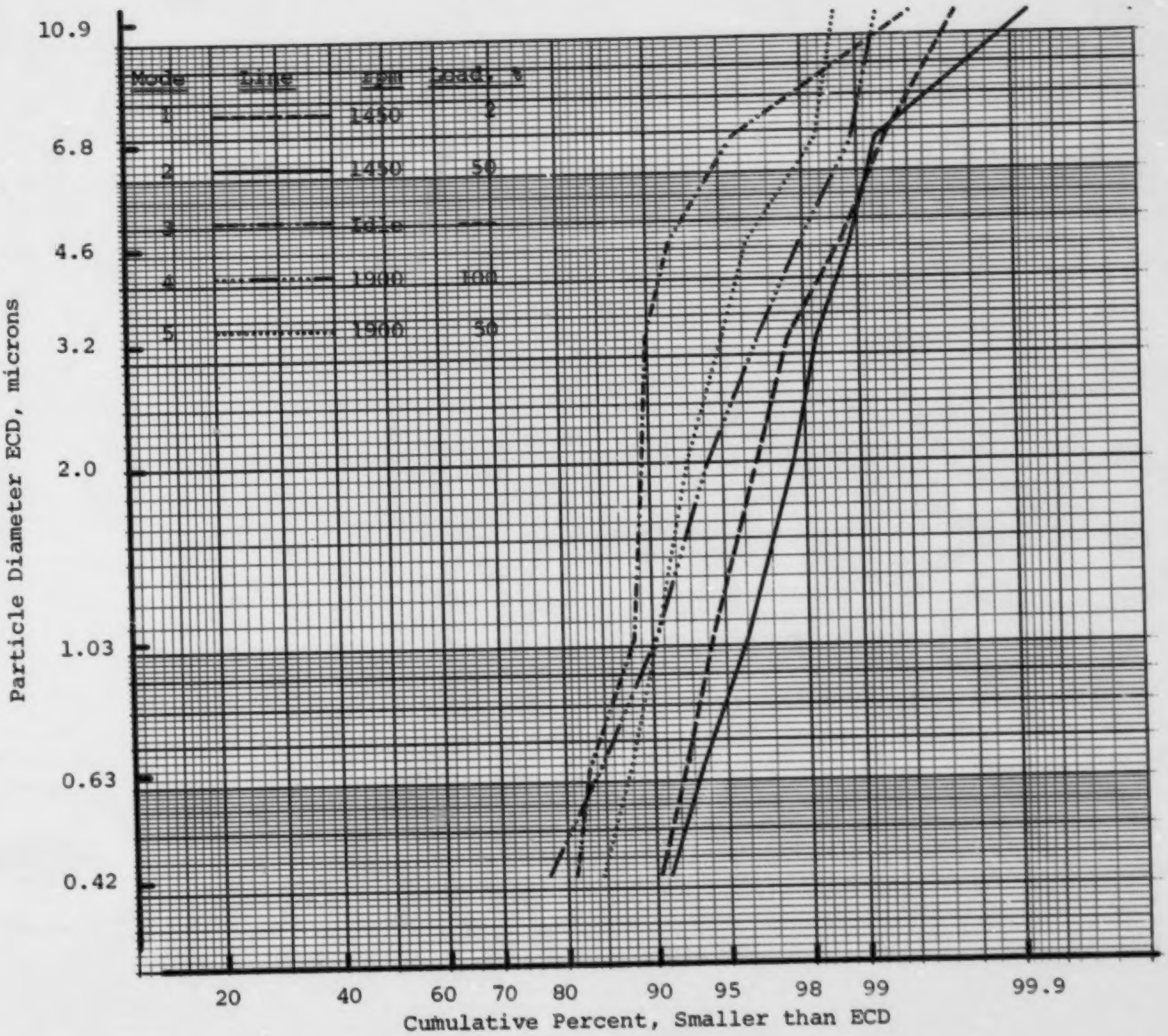

Figure 7. Particle size distribution for Mack ETAY(B) 673A with APE pump, without water

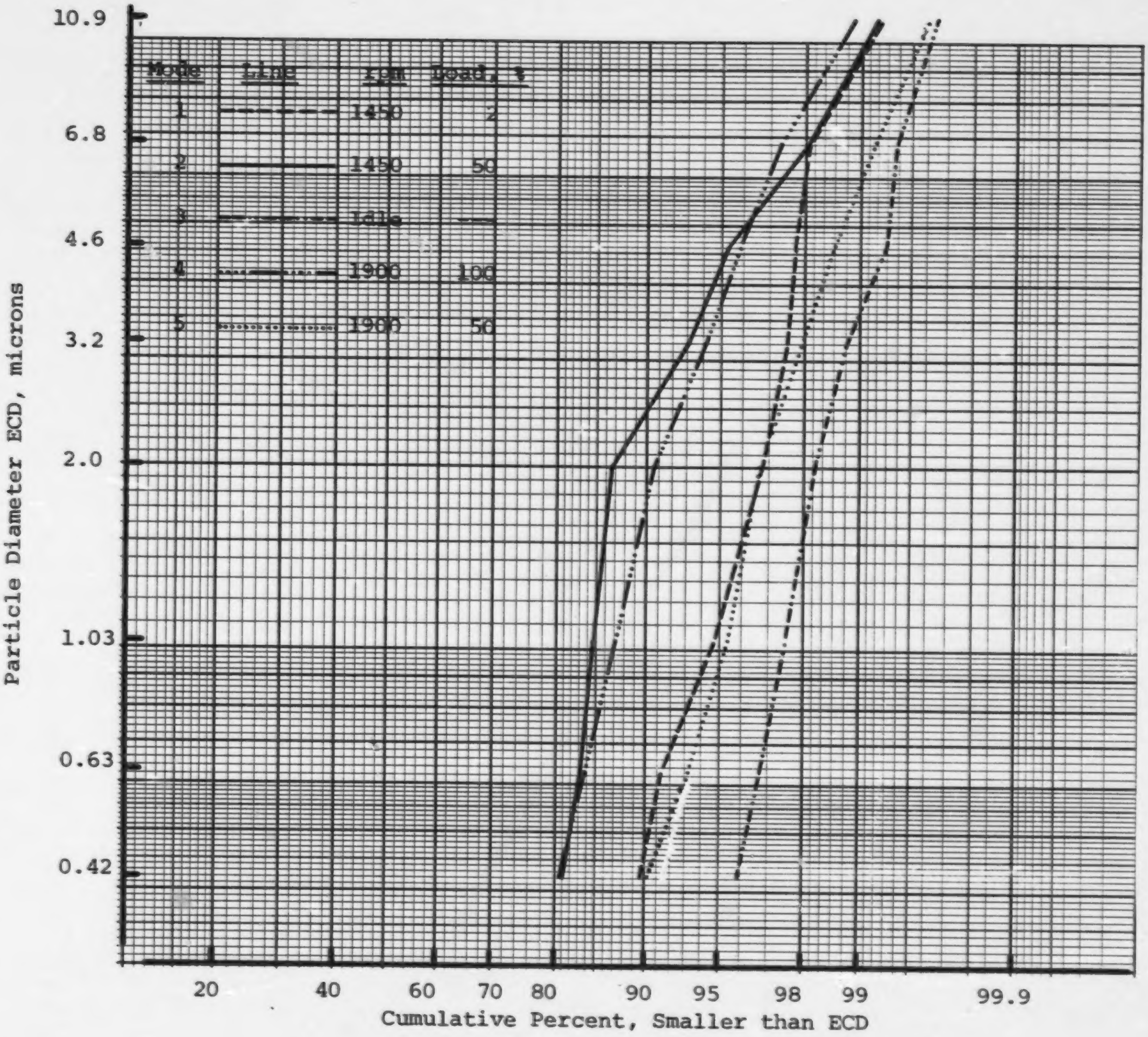

Figure 8. Particle size distribution for Mack ETAY(B) 673A with APE pump, with water

than without. The average H/C mole ratio showed only a minor decrease, from 0.91 to 0.85, when the engine was operated with water addition. The nitrogen content was generally lower when the macroemulsion was used.

TABLE 13. PERCENT CARBON, HYDROGEN, AND NITROGEN IN PARTICULATE FROM MACK ETAY(B) 673A RUN WITH AND WITHOUT WATER ADDITION

Speed, rpm/ Load, %	Carbon, %		Hydrogen, %		H/C Mole Ratio		Nitrogen, %	
	With	Without	With	Without	With	Without	With	Without
1450/2	20.45	28.43	1.45	1.60	0.84	0.67	--	0.98
1450/50	51.15	40.75	2.15	1.61	0.50	0.76	1.30	1.86
1450/100	74.49	45.17	2.58	0.60	0.41	0.15	--	0.78
Idle	31.62	42.16	4.51	5.85	1.70	1.65	0.91	0.82
1900/100	45.70	40.21	1.37	1.90	0.36	0.56	0.90	1.19
1900/50	51.05	32.35	1.79	3.00	0.42	1.11	0.56	0.64
1900/2	33.02	35.30	4.72	4.35	1.70	1.47	0.65	0.73

Results from x-ray fluorescence detection of elements present on particulate-laden 47 mm Fluoropore media from the Mack ETAY(B) 673A, operated with and without water addition, are given in Table 14. Of the eleven elements detected, sulfur, calcium and silicon were the most prevalent. The average percent by weight of sulfur increased from 2.7 to 3.8 when the engine was operated with 30 percent water injection. Calcium was also somewhat higher for runs with water. Detection of zinc was limited to engine operation above 50 percent power. Other elements appeared somewhat randomly, and were generally very low, less than 0.4 percent.

In order to characterize the organic fraction of the total particulate, relatively large particulate samples were needed. Originally, particulate samples were acquired using 8 x 10 inch rectangular-shaped filter media. This filter size generally provided adequate particulate loading to determine the soluble portion of the total particulate by soxhlet extraction with methylene chloride. The resulting extractables or solubles were termed the soluble organic fraction (SOF) of the particulate. This SOF was then analyzed for BaP content. Interest in the health effects associated with diesel exhaust led to interest in assessing the bioactivity of the SOF using the Ames bioassay. The Ames procedure called for a wide range of doses on various tester strains, hence, original estimates of SOF required were on the order of 600 mg. To facilitate collecting large samples of total particulate for extraction to obtain this relatively large quantity of SOF, special 20 x 20 inch filters and holders were developed. A large single dilution CVS was completed and fitted with three 20 x 20 inch filter positions. Particulate samples taken on 8 x 10 inch sheets of Pallflex filter media were stored in favor of obtaining larger particulate samples on 20 x 20 inch filter media.

TABLE 14. ELEMENTAL ANALYSIS OF PARTICULATE SAMPLES FROM THE MACK ETAY(B) 673A RUN WITH AND WITHOUT WATER

Engine rpm/% load	Configuration	% by Weight										
		Al	Si	P	S	Cl	Ca	Ti	Cr	Fe	Zn	Pb
1450/2	APE Pump	--	--	--	1.22	--	--	--	--	--	--	--
	APE + H_2O	0.03	0.11	--	0.15	--	0.54	--	--	--	--	--
1450/25	APE Pump	0.01	0.08	--	4.6	--	0.09	0.01	--	0.61	--	--
	APE + H_2O	--	0.02	--	5.7	--	0.12	--	--	--	--	--
1450/50	APE Pump	0.01	--	--	3.2	--	0.03	--	--	--	0.03	--
	APE + H_2O	0.02	0.03	--	5.6	--	0.12	--	--	--	--	--
1450/75	APE Pump	0.01	--	--	2.5	0.03	0.04	--	--	--	0.04	0.29
	APE + H_2O	--	--	--	3.1	0.02	0.07	--	--	0.05	--	--
1450/100	APE Pump	0.002	0.04	0.03	2.0	0.09	0.07	--	--	0.04	0.02	--
	APE + H_2O	--	0.02	--	4.2	--	0.10	--	--	0.08	0.10	--
Idle	APE Pump	--	0.04	--	3.3	--	0.16	--	--	--	--	--
	APE + H_2O	--	--	--	1.3	--	--	--	0.21	0.10	--	0.92
1900/100	APE Pump	0.003	0.02	0.05	2.6	0.02	0.13	--	0.14	--	0.12	--
	APE + H_2O	0.01	0.02	0.12	6.1	--	0.41	0.01	--	0.21	0.21	--
1900/75	APE Pump	0.02	0.01	--	2.9	--	0.04	--	--	--	0.03	--
	APE + H_2O	0.01	0.01	--	4.9	--	0.08	--	--	--	--	--
1900/50	APE Pump	0.01	0.02	--	2.9	--	0.04	--	--	--	0.03	--
	APE + H_2O	--	0.01	--	4.8	--	0.09	--	--	0.12	0.08	--
1900/25	APE Pump	--	0.01	--	2.6	--	0.28	--	--	--	--	--
	APE + H_2O	--	--	--	5.0	--	0.06	--	0.28	--	--	--
1900/2	APE Pump	--	0.07	--	2.2	--	0.04	--	--	--	--	--
	APE + H_2O	--	0.02	--	1.4	--	0.04	0.01	--	--	--	--

The particulate requirements for Ames testing were later redefined, reducing the amount of extract required for Ames bioassay from 600 to 150 mg. An assumed percent extractables was also reduced from 15 to 10 percent. The Mack ETAY(B) 673A was operated with and without water addition in order to collect sufficient particulate samples over 7 modes of operation. Total exhaust was introduced into the large single-dilution CVS, and three 20 x 20 inch sampling systems were used to collect at least 1.5 grams of particulate matter in each mode. Assuming that 10 percent of the total particulate was extractable, 150 mg of SOF was then available for analysis. Acquisition of these samples completed all characterization requirements on this engine. These filters were shipped to EPA-RTP for extraction and subsequent determination of BaP and bioassay.

Particulate samples on 20 x 20 inch filters, obtained from the Mack ETAY(B) 673A engine run with and without water addition, were processed for organic solubles (SOF) and BaP. Table 15 gives these results on a 7-mode composite basis. Although water addition reduced composite 7-mode total particulate mass emissions by about 58 percent, BaP emissions increased by 25 percent despite no significant change in the brake specific emissions of SOF. Modal values of organic soluble and BaP content are given in Tables A-18 and A-19 of Appendix A, and were used to compute the 7-mode composite rates. The addition of water to the fuel significantly increased organic solubles (from 1.7 g/hr to 6.1 g/hr) at idle. In addition, a significant increase in BaP levels was noted at idle and at light load (2 percent) when water was used..

TABLE 15. SUMMARY OF PARTICULATE, BaP, NO$_x$, AND ORGANIC SOLUBLES FROM THE MACK ETAY(B) 673A WITH APE PUMP

	Seven-Mode Composites of Emissions	
	Without Water	With Water
Particulate[a]		
g/kW-hr	0.71	0.30
g/kg fuel	2.89	1.23
Solubles[a]		
Percent	11.7	27.0
SOF[a]		
mg/kW-hr	83	81
mg/kg fuel	336	362
BaP[a]		
μg/kW-hr	0.180	0.225
μg/kg fuel	0.729	0.924
NO$_x$		
g/kW-hr	8.68	6.52
g/kg fuel	35.21	26.80

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[a] Determined from 20 x 20 samples

Results from Ames bioassay of the soluble organic fraction of the total particulate are given in Tables 16 and 17 for operation without and with water, respectively. Generally, higher levels of bioactivity were noted over strains TA98 and TA100. The highest level of specific activity was noted on strain TA98 from the 1900 rpm/100 percent load run with water. Response and brake specific response were generally greater when water was used.

TABLE 16. SUMMARY OF AMES RESPONSE TO INDIVIDUAL MODAL SAMPLES FROM THE MACK ETAY(B) 673A WITHOUT WATER

Sample Test Condition rpm/% load	Soluble Organic Fraction g SOF/hr	Power Output kW	Metabolic Activation Status	Strain TA98			Strain TA100		
				Specific Activity[a]	Response[b]	Brake[c] Specific Response	Specific Activity[a]	Response[b]	Brake[c] Specific Response
1450/2	5.91	5.0	Yes	0.13	0.77	150	0.33	2.0	390
			No	0.13	0.77	150	0.40	2.4	470
1450/50	4.84	103	Yes	0.12	0.58	6	0.21	1.0	10
			No	0.12	0.58	6	1.1	5.3	50
1450/100	12.9	215	Yes	0.04	0.51	2	0.22	2.8	13
			No	0.10	1.3	6	--	--	--
Idle	1.69	---	Yes	0.12	0.20	--	0.45	0.76	--
			No	0.13	0.22	--	1.2	2.0	--
1900/100	7.98	231	Yes	0.38	3.0	13	0.37	3.0	13
			No	0.31	2.5	11	--	--	--
1900/50	11.7	115	Yes	0.11	1.3	11	0.20	2.3	20
			No	0.13	1.5	13	0.29	3.4	30
1900/2	10.2	5.2	Yes	0.26	2.7	510	0.23	2.3	450
			No	0.14	1.4	280	0.32	3.3	630

---

[a] Specific activity has units of revertants/plate/μg SOF dose and is based on the linear portion of the slope of dose response curve

[b] Response has units of 10^6 revertants/plate/hr and is the product of specific activity and SOF emission rate

[c] Brake specific response has units of 10^3 revertants/plate/kW-hr

TABLE 16 (CONT'D). SUMMARY OF AMES RESPONSE TO INDIVIDUAL MODAL SAMPLES FROM THE MACK ETAY(B) 673A WITHOUT WATER

Sample Test Condition rpm/% load	Soluble Organic Fraction g SOF/hr	Power Output kW	Metabolic Activation Status	Strain TA1535			Strain TA1537			Strain TA1538		
				Specific[a] Activity	Response[b]	Brake[c] Specific Response	Specific[a] Activity	Response[b]	Brake[c] Specific Response	Specific[a] Activity	Response[b]	Brake[c] Specific Response
1450/2	5.91	5.0	Yes	—	—	—	0.07	0.41	83	0.19	1.1	230
			No	0.02	0.12	24	0.07	0.41	83	0.28	1.7	330
1450/50	4.84	103	Yes	—	—	—	0.06	0.29	3	—	—	--
			No	—	—	—	—	—	—	—	—	--
1450/100	12.9	215	Yes	—	—	—	—	—	—	—	—	--
			No	—	—	—	—	—	—	—	—	--
Idle	1.69	——	Yes	—	—	—	0.08	0.14	—	0.13	0.22	--
			No	0.02	0.034	—	0.05	0.09	—	0.22	0.37	--
1900/100	7.98	231	Yes	—	—	—	—	—	—	—	—	--
			No	—	—	—	—	—	—	—	—	--
1900/50	11.7	115	Yes	—	—	—	0.05	0.59	5	—	—	--
			No	0.01	0.12	1	0.06	0.70	6	—	—	--
1900/2	10.2	5.2	Yes	—	—	—	0.08	0.82	160	0.15	1.5	290
			No	0.02	0.20	39	0.05	0.51	100	0.10	1.0	200

---

[a] Specific activity has units of revertants/plate/µg SOF dose and is based on the linear portion of the slope of dose response curve

[b] Response has units of 10^6 revertants/plate/hr and is the product of specific activity and SOF emission rate

[c] Brake specific response has units of 10^3 revertants/plate/kW-hr

TABLE 17. SUMMARY OF AMES RESPONSE TO INDIVIDUAL MODAL SAMPLES FROM THE MACK ETAY(B) 673A WITH WATER

Sample Test Condition rpm/% load	Soluble Organic Fraction g SOF/hr	Power Output kW	Metabolic Activation Status	Strain TA98			Strain TA100		
				Specific Activity[a]	Response[b]	Brake[c] Specific Response	Specific Activity[a]	Response[b]	Brake[c] Specific Response
1450/2	6.96	5.0	Yes	0.14[d]	0.97	190	0.45	3.1	630
			No	0.16	1.1	220	1.2	8.4	1700
1450/50	3.97	106	Yes	0.23	0.91	9	0.28	1.1	11
			No	0.10	1.1	11	--	--	--
1450/100	4.64	214	Yes	0.24	1.1	5	0.24	1.1	5
			No	0.12	0.56	3	0.75	3.5	16
Idle	6.09	---	Yes	0.20	1.2	--	0.30	1.8	--
			No	0.04	0.24	--	0.63	3.8	--
1900/100	4.31	236	Yes	0.55	2.4	10	1.2	5.2	22
			No	0.48	2.1	9	1.1	4.7	20
1900/50	10.4	118	Yes	0.36	3.7	32	0.18	1.9	16
			No	0.12	1.2	11	0.32	3.3	28
1900/2	16.3	3.6	Yes	0.11	1.8	500	0.35	5.7	1600
			No	0.09	1.5	410	0.84	14.	3800

---

[a] Specific activity has units of revertants/plate/μg SOF dose and is based on the linear portion of the slope of dose response curve

[b] Response has units of 10^6 revertants/plate/hr and is the product of specific activity and SOF emission rate

[c] Brake specific response has units of 10^3 revertants/plate/kW-hr

[d] Average of two determinations

TABLE 17 (CONT'D). SUMMARY OF AMES RESPONSE TO INDIVIDUAL MODAL SAMPLES FROM THE MACK ETAY(B) 673A WITH WATER

Sample Test Condition rpm/% load	Soluble Organic Fraction g SOF/hr	Power Output kW	Metabolic Activation Status	Strain TA1535			Strain TA1537			Strain TA1538		
				Specific Activity[a]	Response[b]	Brake[c] Specific Response	Specific Activity[a]	Response[b]	Brake[c] Specific Response	Specific Activity[a]	Response[b]	Brake[c] Specific Response
1450/2	6.96	5.0	Yes	—	—	—	0.06	0.42	84	0.13	0.90	180
			No	0.02	0.14	28	0.16	1.1	220	0.26	1.8	360
1450/50	3.97	106	Yes	—	—	—	0.11	0.44	4	—	—	—
			No	0.00	0.00	0	0.05	0.20	2	—	—	—
1450/100	4.64	214	Yes	—	—	—	—	—	—	—	—	—
			No	—	—	—	—	—	—	—	—	—
Idle	6.09	—	Yes	—	—	—	0.02	0.12	—	0.24	1.5	—
			No	0.01	0.06	—	0.07	0.43	—	0.12	0.73	—
1900/100	4.31	236	Yes	—	—	—	—	—	—	—	—	—
			No	—	—	—	—	—	—	—	—	—
1900/50	10.4	118	Yes	—	—	—	0.15	1.6	13	0.24	2.5	21
			No	0.02	0.21	2	0.09	0.94	8	0.16	1.7	14
1900/2	16.3	3.6	Yes	—	—	—	0.05	0.82	230	0.16	2.6	720
			No	0.02	0.33	90	0.04	0.65	180	0.30	4.9	1400

---

[a] Specific activity has units of revertants/plate/μg SOF dose and is based on the linear portion of the slope of dose respone curve

[b] Response has units of 10^6 revertants/plate/hr and is the product of specific activity and SOF emission rate

[c] Brake specific response has units of 10^3 revertants/plate/kW

IV. CONFIRMATORY EMISSIONS TEST WORK ON THE CHEVROLET 366 HEAVY-DUTY GASOLINE ENGINE

This section of the report describes the test work performed on the Chevrolet 366 heavy-duty gasoline engine. Emissions characterization work performed under this program was conducted to confirm and expand the data base initiated in an earlier program. Some background information is given along with the description of the engine. Special preparations are described, and the properties of the test fuel used in this program are compared to those of the fuel used in the earlier work. At the time this work was performed, the main emphasis was to obtain large particulate samples for subsequent analysis of organic solubles, BaP, and Ames bioassay. Results from these analyses are given along with other results obtained over the course of this portion of the program.

A. Background Information and Test Engine Description

Under a previous program, EPA Contract No. 68-03-2417, emission levels for the Chevrolet 366 heavy-duty gasoline engine (modified to meet 1977 California standards) were reported.(5) In that study, emission levels from this gasoline engine were compared to those of a Caterpillar 3208 diesel engine with EGR. Although particulate levels from the leaded gasoline engine were much lower than from the diesel engine, the gasoline engine had higher cycle composite emissions of BaP (3.0 vs 2.5 µg/kW-hr). Test conditions of full power-1200 rpm and 2300 rpm on the Chevrolet 366 engine showed relatively high levels of BaP. Higher emissions of benzaldehyde, crotonaldehyde, and formaldehyde were also noted for the gasoline engine compared to the diesel engine. In addition, the Chevrolet 366 engine emitted much more methane, benzene, and toluene than the diesel engine. Based on these results, more work was needed to explain or isolate the reasons for the high emissions of BaP noted during full power operation of this gasoline engine.

A test program was developed to verify the previous BaP results and to discover what variables may have caused those results. The intended test work on the Chevrolet 366 engine was broken into four basic steps: 1) verify and quantify previous results obtained almost 2 years before; 2) adjust carburetor to "lean best power" at the full-power condition and retest; 3) conduct experiments with unleaded fuel, depending on the results of Steps 1 and 2; and 4) run tests with catalyst or fuel variations if authorized by the Project Officer based on Steps 1 through 3.

The 1977 Chevrolet 366 cubic inch heavy-duty gasoline engine had been modified for EGR and air injection to meet 1977 California emission standards. The engine was rated for 185 hp at 4000 rpm on regular leaded gasoline, with a peak torque of 290 ft-lb in the single-exhaust configuration. The compression ratio of this engine was 7.6:1. The same engine used in the previous work (Serial No. 19645-72C) was mounted for steady-state dynamometer testing as shown in Figure 9. In setting up to test the Chevrolet 366 after two years of non-use, it was noted that the engine had a cracked manifold. A new manifold and air-injection manifold (tubing) was fitted to the engine along with a new set of spark plug wires and a revised flywheel adapter.

TABLE 18. GASOLINE SPECIFICATIONS FOR CHEVROLET 366 TESTS

Property	EM-275-F, Old Gasoline		EM-411-F, Gasoline Received 12/79		EM-433-F, Gasoline received 2/19/80, Howell Analysis
	Reported Earlier	Div. 10 (12/79)	Howell Analysis	Div. 10 Analysis	
Gravity, °API	61.1[a]		62.8	62.6	59.7
RVP, psi	7.5		8.2		7.9
Octane, F-1	91.8		91.6		92.0
Total S, %	0.030		0.021		0.022
g Pb/gal	1.60		1.63	1.34	1.64
Aromatics, %	49.9[b]	36.3	12.9	12.5	29.8
Olefins, %	5.2[b]	1.1	0.7	0.9	
ASTM D86					
IBP, °F	98[d]		87	91[c]	95
5	130		126	135	118
10	150		150	159	130
20	176		182	192	142
30			206	207	160
40			216	219	180
50	220		222	227	207
60			236	237	224
70	242		247	249	246
80			264	264	272
90			302	291	310
95	307		342	312	325
EP, °F	340		386	350	357
Residue	0.4		1.0	1.5	1.0
Loss	1.0		2.0	1.0	1.0
ρ, g/mℓ	0.7347		0.7283	0.7290	0.740

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[a] Earlier value of 54.2 was apparent miscalculation by Howell

[b] SwRI Division 08 result, probably erroneous

[c] This distillation reported as % evaporated

[d] This distillation reported as % recovered

particulate samples were taken on 47 mm filters to check the engine's particulate emission rate. Gaseous emissions were also measured over a simulated 13-mode test to check for reproducibility of emissions observed during the "2417" Contract and to compute engine exhaust flows at the test conditions of interest.

Gaseous emissions from the Chevrolet 366 gasoline engine measured under this Contract ("2706") are shown in Table 19, as compared to emissions measured from the same engine several years earlier under the "2417" Contract.(5) The most substantial emissions difference occurred in gaseous HC, with the engine producing higher concentrations than it did in the previous work. It is possible that some part of this difference was due to use of a different fuel, but there was no rigorous way of determining the complete reason or reasons within the scope of this program.

TABLE 19. 13-MODE GASEOUS EMISSIONS FROM CHEVROLET 366 ENGINE

Mode	Speed, rpm	Power, Gaseous Emissions, and Fuel Rate by Contract Number									
		Power, kW		HC, g/h		CO, g/h		NO_x, g/h		Fuel, kg/h	
		2417	2706	2417	2706	2417	2706	2417	2706	2417	2705
1	700	--	--	37	74	198	185	2	2	2.6	2.5
2	1200	1	0.4	2	6	114	90	8	5	4.5	4.1
3	1200	11	11.2	5	14	296	233	30	33	6.4	5.9
4	1200	22	22.1	10	30	801	862	91	102	8.5	8.2
5	1200	33	33.3	16	63	1987	1807	136	146	11.9	11.6
6	1200	43	44.5	143	205	9130	8750	92	80	15.9	16.5
7	700	--	--	26	139	199	338	2	2	2.6	2.5
8	2300	88	90.0	259	342	27614	24165	11	98	34.9	33.8
9	2300	66	67.7	6	25	2984	5571	302	179	23.2	24.3
10	2300	44	45.0	1	2	373	715	161	121	17.5	17.5
11	2300	22	22.7	1	2	132	274	50	59	12.5	11.8
12	2300	2	1.7	2	4	137	167	17	16	7.4	7.0
13	700	--	--	42	110	209	136	1	1	2.6	1.5
Weighted		26.560	27.088	42.60	76.973	3511	3455	72.17	67.45	11.94	11.69
Weighted g/kW-hr				1.60	2.84	132.2	127.5	2.72	2.49	449	432

Data pertinent to particulate collection runs are presented in Table 20. The test at 2300 rpm/100% load was conducted for 2.25 hours, continuously. The major criterion used to determine a cutoff point was an increase in Δp across the positive displacement pump sampling through 20 x 20 Pallflex filters to 46 inches H_2O from the initial value of 42 inches H_2O. The higher Δp figure was about the maximum of which the pump and motor were capable. The

TABLE 20. DATA FROM PARTICULATE COLLECTION EXPERIMENTS WITH CHEVROLET 366 GASOLINE ENGINE

Engine operating conditions	2300 rpm, 100% load				2300 rpm, 50% load			
Date(s) of collection run	2/29/80				3/3/80 and 3/4/80			
Duration of collection run	135 min				285 min			
Dilute exhaust flow, total	911.85 kg/h (2010.25 lbm/h)				AVG. 924.11 kg/h (2037.27 lbm/h)			
Raw exhaust into tunnel	55.04 kg/h (121.35 lbm/h)				AVG. 50.31 kg/h (100.91 lbm/h)			
Engine exhaust rate, calculated	456.82 kg/h (1007.1 lbm/h)				279.42 kg/h (616.00 lbm/h)			
Fraction of engine exhaust entering tunnel	0.1205				AVG. 0.1801			
Calculated molecular wt. of raw exhaust gas	27.84				29.034			
Particulate samples & rates								
47mm filter type-no.	47PL-403	47FH-401	A47-403	A47-402	47FH-402	47PL-401	A47-404	A47-405
holder number	1	2	3	4	1	2	3	4
collected wt., mg	6.204	4.912	8.557	8.335	4.919	5.059	5.926	6.081
dilute exhaust filtered, ft^{3a}	104.57	85.43	124.04	132.70	121.13	148.16	139.90	149.91
calculated engine particulate rate, g/h	13.21	12.80	15.35	13.98	5.77	4.85	6.02	5.76
47mm filter type-no.	----[b]	----	----	----	47FH-403	47PL-402	A47-406	A47-407
holder number	1	2	3	4	1	2	3	4
collected wt., mg	----	----	----	----	4.128	4.754	4.885	4.936
dilute exhaust filtered, ft^{3a}	----	----	----	----	116.25	134.05	126.61	136.31
calculated engine particulate rate, g/h	----	----	----	----	5.43	5.42	5.90	5.53
20 x 20 Pallflex filter	PL-405	PL-406	PL-407	PL-408	PL-409	PL-410	PL-411	PL-412
collected wt., g	0.9344	0.9397	0.9221	0.9278	1.3000	1.1944	1.1880	1.0805
composite calculated engine particulate rate, g/h	13.74				6.03			

[a] at 29.92" Hg and 528°R (20°C)
[b] no data

contribution of the 20 x 20 filters themselves to the system pressure drop changed from about 26.3 inches H_2O when clean to 32.5 inches H_2O when fully loaded. The particulate matter observed was a very light gray in color, almost indistinguishable from the surface of the filter itself. Using the previously-determined value of 3.9% by mass, the 3.7240 grams of particulate matter collected on the four 20 x 20 filters were expected to yield about 145 mg solubles for Ames and BaP analysis.

The test at 2300 rpm/50% load was conducted in two segments of 2.50 hours and 2.25 hours, respectively. The 20 x 20 filters were left sealed in the tunnel overnight between parts of the collection run. Two sets of 47 mm filters were used. The particulate matter collected in these runs looked exactly like that collected at full load. In this case, the 4.7629 grams of particulate matter collected should yield about 124.8 mg solubles at 2.62% by mass (as determined in Contract "2417"). Pressure drop across the filters increased from about 26.3 inches H_2O to 32.4 inches H_2O over the total period of the test runs.

Analyzing the total particulate rates observed, good agreement of all filters and filter systems was noted internal to each operating condition. As compared to results from the "2417" Contract, the latest results showed lower total particulate emissions at 100% load (14.7 g/h average 47 mm G.F. this work vs 26.1 g/h previously), but approximately equal total particulate emissions at 50% load (5.8 g/h average 47 mm G.F. this work versus 6.1 g/h previously).

Filters designated for analysis were shipped to the responsible persons or organizations. Table 21 shows the disposition of these filters, corresponding blanks where appropriate, and CABS numbers for the 20 x 20 filters. RTP was responsible for obtaining the organic soluble fraction (SOF) from the particulate collected on the 20 x 20 filters. In addition, RTP would determine BaP and Ames bioassay of the resulting solubles. Small particulate samples collected on 47 mm Fluoropore media were submitted to RTP for analysis by x-ray diffraction. Carbon, hydrogen, and nitrogen content of the particulate was determined by Galbraith Laboratories, Inc.

Results from analysis of particulate for metals and C, H, and N are given in Table 22. As expected, the dominant elements were lead, bromine, and chlorine. If all the lead and halogens were present as the compound PbBrCl, the elemental weight ratios would be 0.64/0.25/0.11. Our samples, represented as elemental weight ratios, were 0.52/0.27/0.20 at 100% load, and 0.60/0.29/0.10 and 0.59/0.30/0.11 at 50% load. The three compounds (Pb, Br, & Cl) constituted 83.5 to 86.6 weight percent of the particulate matter collected on Fluoropore filters.

With regards to C, H, and N, the high-power condition apparently yielded less carbon than the 50% load condition, contrary to expectations since exhaust CO level was about 6 percent at full power versus about 0.3 percent at half power. None of the filters collected any visible carbon, such as would be expected under a "black smoke" condition. If the carbon and hydrogen percentages determined by combustion were a reliable indication, the samples of particulate matter would contain only 1 to 2 percent solubles.

TABLE 21. DISPOSITION OF SAMPLE FILTERS FROM TEST RUNS ON CHEVROLET 366 GASOLINE ENGINE, 2/29-3/4-80

Engine operating condition	2300 rpm, 100% load	2300 rpm, 50% load		Corresponding blank	Disposition
Date(s) of test	2/29/80	3/3/80	3/4/80		
Fluoropore 47mm filter no(s). collected wt., mg	47FH-401 4.912	47FH-402 4.919	47FH-403 4.128	47FH-406 --	RTP for X-ray
Pallflex 47 mm filter no(s). collected wt., mg	47PL-403 6.204	47PL-401 5.059	47PL-402 4.754	47PL-406 --	SwRI for micro soxhlet
G.F. 47mm filter no(s). collected wt., mg	A47-402 8.335	A47-404 5.926	A47-406 4.885	A47-412 --	Galbraith for CHN
G.F. 47mm filter no(s). collected wt., mg	A47-403 8.557	A47-405 6.081	A47-407 4.936	A47-413 --	SwRI for micro soxhlet
Pallflex 20x20 filter no. assigned no. (EPA) collected et., mg	PL-405 CABS-80-0840 934.4	PL-409 CABS-80-0880 1300.0		-- -- --	RTP for Ames, BaP
Pallflex 20x20 filter no. assigned no. (EPA) collected wt., mg	PL-406 CABS-80-0850 939.7	PL-410 CABS-80-0890 1194.4		-- -- --	RTP for Ames, BaP
Pallflex 20x20 filter no. assigned no. (EPA) collected wt., mg	PL-407 CABS-80-0860 922.1	PL-411 CABS-80-0900 1188.0		-- -- --	RTP for Ames, BaP
Pallflex 20x20 filter no. assigned no. (EPA) collected wt., mg	PL-408 CABS-80-0870 927.8	PL-412 CABS-80-0910 1080.5		-- -- --	RTP for Ames, BaP

TABLE 22. ANALYSIS OF PARTICULATE SAMPLES COLLECTED ON 47 mm FILTERS, CHEVROLET 366 GASOLINE ENGINE

Engine Operating Condition Collection Date	2300rpm, 100% load 2/29/80		2300rpm, 50% load 3/3/80		2300rpm, 50% load 3/4/80	
Filter Types, Numbers	47FH-401	A47-402	45FH-402	A47-404	47FH-403	A47-406
Particulate Weight on Filter, mg	4.912	8.335	4.919	5.926	4.128	4.885
Calculated Particulate Rate, g/h	12.80	13.98	5.77	6.02	5.43	5.90
Major Elements in % of particulate						
Pb	43.4	--	51.3	--	50.8	--
Br	22.6	--	24.8	--	25.9	--
Cl	16.8	--	8.9	--	9.3	--
C	--	2.07	--	8.06	--	8.23
H	--	1.93	--	0.66	--	0.61
N	--	5.45	--	2.90	--	3.46
Minor Elements in µg on filter						
Na	9.1	--	14.	--	11.	--
Mg	2.1	--	2.5	--	2.1	--
Si	1.6	--	1.1	--	0.5	--
P	1.8	--	1.7	--	1.3	--
K	0.1	--	0.2	--	0.1	--
Ca	3.6	--	1.6	--	0.6	--
Ti	0.1	--	--	--	--	--
Cr	--	--	--	--	1.2	--
Fe	11.	--	5.1	--	1.1	--
Cu	2.0	--	1.7	--	1.5	--
Zn	5.0	--	5.6	--	1.9	--

A decision was reached by the Project Officer on May 7, 1980, that we should proceed to collect additional 20 x 20 filter samples of particulate matter from the Chevrolet 366 at its existing mixture setting (stock), then proceed to collect 20 x 20 filter samples at a "lean best power" (our term) setting. All these additional samples, collected at 2300 rpm and 100% load, are listed in Table 23. It was understood that since no Ames tests were to be conducted on these samples, assignment of CABS numbers was not necessary.

The Project Officer was contacted on May 13, and he subsequently confirmed that the total of 18.96 grams particulate matter would be sufficient after conferring with Joellen Huisingh of RTP. The additional filters were sent to Bob Jungers at EPA-RTP on May 14, 1980.

The engine F/A setting was changed in preparation for sample collection under "lean" conditions. The engine had been operating at about 6 percent CO, and our targets were 1 percent CO (or less) with reasonable operability and a drop in power of 1 percent or less from the observed maximum value.

The sequence of carburetor jet configurations evaluated was as follows:

	Jet Sizes, Inches		Results		
Configuration	Primary	Secondary	Load	% CO	Operability
Stock	0.0632	0.071	208	6.0	OK
Step 1	0.0632	0.062	208	2.8	OK
Step 2	0.0632	0.0542	208	2.1	OK
Step 3[a]	0.0542	0.0542	196	0.2	died at idle
Step 4[a]	0.055[b]+	0.0542	205	0.5	rough idle, but ran

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[a] Idle air screws full out (richest) position

[b] No 50 drill = 0.055 in.

The "Step 4" configuration was used for the sample collection under "lean" conditions, and the engine was left in this trim pending the outcome of all the particulate analyses.

In contrast to the "stock" (rich) collection experiments, during which filters increased in pressure drop to system maximum over a period of two to three hours, filters used for "lean" collection increased in Δp very slowly. This difference meant that each set of 4 filters could be used for a longer period of time, and in the process, that each filter could accumulate a larger mass of particulate matter. Filter codes and loadings for the eight filters used to collection particulate matter under lean conditions are summarized in Table 24. The total amount of particulate matter collected on the eight filters was

TABLE 23. FILTER NUMBERS AND COLLECTED PARTICULATE WEIGHTS, CHEVROLET 366 GASOLINE ENGINE, FULL POWER OPERATING AT 2300 rpm, STANDARD CARBURETOR JETTING

Date Used	Filter Number	Wt. Particulate Collected, g	Wt. Subtotal for Run, g	Collection Rate, g/h
5/8/80	5428-P20-01	1.3593		
	-02	1.3432		
	-03	1.3991		
	-04	1.3616	5.46	1.82
5/9/80 (am)	5428-P20-05	0.9873		
	-06	0.9825		
	-07	0.9700		
	-08	0.9571	3.89	1.94
5/9/80 (pm)	5428-P20-09	0.9623		
	-10	0.9841		
	-11	0.9806		
	-12	0.9643	3.90	1.73
5/12/80	5428-P20-13	1.4543		
	-14	1.4765		
	-15	1.3875		
	-16	1.3884	5.71	1.63

approximately 23.97 grams, which was considered sufficient for analysis purposes. After reporting these results to the Project Officer, the samples were sent to EMSL for solubles, BaP, and Ames analyses. A few samples were taken on 47 mm filters for other analyses while the 20 x 20's were being loaded.

TABLE 24. FILTER NUMBERS AND COLLECTED PARTICULATE WEIGHTS, CHEVROLET 366 GASOLINE ENGINE WITH LEAN CARBURETOR SETTING, 2300 RPM AND FULL LOAD

Date(s) Used	SwRI Filter Number	CABS Filter Number	Wt. Particulate Collected, g	Collection Rate, g/h
5/14-5/19/80	5428-P20-17	CABS-80-0060	3.7674	1.25
	5428-P20-18	CABS-80-0070	3.7905	
	5428-P20-19	CABS-80-0080	3.7667	
	5428-P20-20	CABS-80-0090	3.6997	
5/20-5/21/80	5428-P20-25	CABS-80-0100	2.2776	1.05
	5428-P20-26	CABS-80-0110	2.2178	
	5428-P20-27	CABS-80-0120	2.2309	
	5428-P20-28	CABS-80-0130	2.2167	

Results of analyses performed on the 47 mm filter samples are summarized in Table 25. This table also contains engine, tunnel, and sample flowrate data; collected particulate masses; and computed engine particulate emission rates. The emission rates of 8.1 to 10.6 g/h (Pallflex) (average emission rate was 9.2 g/hr) computed for lean operation were about 23 percent lower compared to the rates determined for rich operation, which were 13.2 to 13.7 g/h.

Analysis of particulate matter collected on 47 mm filters, shown in Table 25, can be compared to corresponding results for rich operation. This comparison shows lower C, H, and N during lean operation, comparable Br and Cl, and somewhat higher Pb during lean operation.

Of the several samples of particulate generated during the course of this program, many of the particulate-laden filters were assigned identification numbers for subsequent solubles, BaP and Ames bioassay analyses. Original plans called for many replicate analyses, especially on the Ames bioassay. During the time period that these particulate samples were obtained, much work on solubles, BaP, and Ames bioassay was being conducted nationwide in order to assess the potential hazards of materials found in combustion engine exhaust. To expedite analyses, many of the individual particulate samples were combined into single samples by EPA in order to streamline the handling and analyses. Table 24 gives the combinations formed by EPA from the various samples obtained during this test work.

TABLE 25. DATA FROM PARTICULATE COLLECTION EXPERIMENTS WITH CHEVROLET 366 GASOLINE ENGINE, LEAN CARBURETOR ADJUSTMENT

Engine Operating Conditions	2300 rpm, 100% load, lean carburetor adjustment							
Date(s) of collection run	20x20, 5/14-5/19; 47mm, 5/16				20x20, 5/20 & 5/21; 47mm, 5/21			
Duration of collection run	20x20, 11h; 47mm, 2.5h max.				20x20, 8.5h; 47mm, 6.5h max.			
Dilute exhaust flowrate	all - 905 kg/h (1995 lbm/h)				20x20, 887 kg/h; 47mm, 879 kg/h			
Raw exhaust rate into tunnel	20x20, 54.8 kg/h; 47mm, 68.5 kg/h				20x20, 49.5 kg/h; 47mm , 49.5 kg/h			
Engine exhaust rate, calculated	all - 425 kg/h (936 lbm/h)				all - 425 kg/h (936 lbm/h)			
Fraction engine exh. into tunnel	20x20, 0.1291; 47mm, 0.1613				20x20, 0.1166; 47mm, 0.1166			
Raw exhaust m.w., calculated	all - 29.03				all - 29.03			
	Particulate Samples and Rates							
47mm filter type-number	P47-1	F47-1	A47-1	A47-2	F47-3	P47-3	A47-5	A47-6
holder number	1	2	3	4	1	2	3	4
collected weight, mg	7.698	4.206	9.741	7.089	10.268	12.387	15.190	14.715
dilute exhaust filtered, ft^3 [a]	149.5	73.6	149.7	149.2	270.4	349.3	361.5	361.5
engine particulate emission rate (calculated), g/h	8.5	9.4	10.7	7.8[b]	8.6	8.1	9.6	9.3
	Major Elements in % of Particulate							
Pb	[c]	59.3			56.2			
Br		25.4			21.9			
Cl		2.4[d]			12.3			
C			<0.1					0.19
H			0.23					0.34
N			0.68					0.89
	Minor Elements in μg/filter							
Na	[c]	---[e]			36.			
Mg		---			5.0			
Si		2.2			4.7			
P		0.2			7.5			
K		0.1			0.3			
Ca		1.9			11.			
Ti		0.1			0.3			
V		0.4			0.5			
Cr		---			1.4			
Fe		18.			17.			
Cu		1.6			3.9			
Zn		5.2			8.5			
Sn		---			1.4			
Sb		---			0.4			
Ba		---			0.3			
20x20 Pallflex Filter No.	P20-17	P20-18	P20-19	P20-20	P20-25	P20-26	P20-27	P20-28
Collected weight, g	3.7674	3.7905	3.7667	3.6997	2.2776	2.2178	2.2309	2.2167
Composite calculated engine particulate emission rate, g/h	10.6				9.0			

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[a] at 29.92 in Hg and 528°R (20°C)

[b] probably an erroneous result due to filter case leakage

[c] no analysis conducted where blanks appear in this section

[d] anomalous result, no explanation

[e] dashes indicate "none detected" in this section

TABLE 26. COMBINATIONS OF PARTICULATE SAMPLE FOR SUBSEQUENT ANALYSIS

Engine Condition	Chevrolet 366 California		
	Carburetor Set as "Stock"		Carb. Set as "Lean"
	2300 rpm/100% load	2300 rpm/50% load	2300 rpm/100% load
Assigned EPA Sample No.	CABS-80-0840[a]	CABS-80-0880[a]	CABS-80-0060[b]
	CABS-80-0850	CABS-80-0890	CABS-80-0070
	CABS-80-0860	CABS-80-0900	CABS-80-0080
	CABS-80-0870	CABS-80-0910	CABS-80-0090
			CABS-80-0100
			CABS-80-0110
			CABS-80-0120
			CABS-80-0130
Combined EPA Sample No.	CABS-80-0841	CABS-80-0881	CABS-80-0131

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[a] The corresponding filters were tabulated in Table 21
[b] The corresponding filters were tabulated in Table 24

Sample CABS-80-0841 from the "stock" configuration run at 2300 rpm/100 percent load was analyzed for organic solubles and BaP content and resulted in 2.06 percent solubles with a brake specific BaP emission of 0.16 µg BaP/kW-hr. Similar analysis of sample CABS-80-0881 (2300 rpm/50 percent load) was conducted and resulted in a 1.15 percent solubles with a brake specific BaP emission of 0.0019 µg BaP/kW-hr. Both of these SOF samples were tested for bioactivity using the Ames test on Strain TA100. Results from this limited Ames testing are given in Table 27.

TABLE 27. SUMMARY OF AMES BIOASSAY OF SOF FROM THE CHEVROLET 366 IN "STOCK" CONFIGURATION ON TESTER STRAIN TA100.

Test Condition, rpm/% load	SOF Emission, mg/kW-hr	Metabolic Activation Status	Specific Activity, rev/µg dose	Brake Specific Response, 10^3rev/plate/kW-hr
2300/100	3.13	Yes	3.0	9.4
		No	4.4	14
2300/50	1.53	Yes	1.5	2.3
		No	12	18

Analysis of CABS-80-0131, the combined sample for the "lean" carburetor setting, showed that the soluble organic fraction made up 0.5 percent of the total particulate collected. Analysis of this SOF indicated BaP as 0.00031 µg

BaP/kW-hr. Results of bioassay for the SOF are given in Table 28. Compared to results in Table 27, it appears that potential bioactive compounds in the SOF were reduced when the engine was readjusted to run lean at full power.

TABLE 28. SUMMARY OF AMES BIOASSAY OF SOF[b] FROM THE CHEVROLET 366 ADJUSTED LEAN

Tester Strain	Metabolic Activation Status	Specific Activity rev/μg dose Test 1	Specific Activity rev/μg dose Test 2	Brake Specific Response, Avg. 10^3 rev/plate/kW-hr
TA98	No	a	6.7	3.7
	Yes	1.2	1.6	0.8
TA100	No	a	4.1	2.2
	Yes	1.6	1.4	0.8
TA1538	No	a	0.7	0.4
	Yes	1.3	1.0	0.6

---

[a] Insufficient data for statistical analysis

[b] Based on max. power operation, average particulate rate was 9.8 g/hr, max. power 88 kW, brake specific particulate 0.11 g/kW-hr; extractables were 0.5 percent by mass or 0.55 mg SOF/kW-hr

V. EMISSIONS CHARACTERIZATION OF A CUMMINS VTB-903 AND A DETROIT DIESEL 6V-71N IN BASELINE AND MALADJUSTED CONFIGURATIONS

The purpose of this portion of the program was to characterize emissions from two heavy-duty bus engines in both baseline and maladjusted configurations. The maladjustments were intended to simulate some degree of wear and/or lack of maintenance. It was decided that maladjusted configurations should represent a field condition in which the bus would remain in service due to adequate performance, but with a "smokey" exhaust. The two dissimilar engines selected for use in this work were the Cummins VTB-903 and the Detroit Diesel 6V-71N. This section is divided into three smaller subsections. Subsection A describes the test procedures, along with the analytical procedures used to determine the exhaust emissions. Subsection B describes the work performed and the emissions results from the Cummins VTB-903. Subsection C describes the work performed and the emission results from the DDAD 6V-71N. Detailed data are presented in Appendix B for the Cummins VTB-903 and in Appendix C for the DDAD 6V-71N.

A. Test and Analytical Procedures

During the time period when this work was performed, EPA had proposed a new transient test procedure(2,13) to replace the existing 1979 13-mode steady-state test procedure for emissions measurement. This new proposed transient procedure was already being used to establish emission levels from several different heavy-duty diesel and gasoline engines at SwRI under EPA Contract 68-03-2603 (1977-1980).(14)

Emissions from both the VTB-903 and the DDAD 6V-71N were measured during both steady-state and transient engine exercises. Steady-state operation and measurement techniques were based on the 1979 13-mode Federal Test Procedure (FTP).(1) Transient operation and measurement techniques were based on the 1984 Transient FTP.(2)

1. Test Procedures

The 13-mode test procedure is an engine emission test cycle which consists of 13 individual modes of steady-state operation. Starting with a fully warmed engine, the first mode is an idle condition. This idle is then followed by 2, 25, 50, 75, and 100 percent load at intermediate speed followed by another idle mode, then to rated speed - 100, 75, 50, 25, and 2 percent of full load, followed by a final idle mode. Intake air, fuel, and power output are monitored along with other data to be used in calculating modal emission rates. Composite 13-mode emissions are calculated on the basis of modal weighting factors as specified in the Federal Register.(1)

Most unregulated emissions were measured over 7 modes of steady-state operation instead of 13 modes. This 7-mode procedure is a variation of the 13-mode procedure and consists of only the 2, 50, and 100 percent loads at intermediate and rated speeds, plus one idle condition.

On the basis of the 13-mode FTP weighting factors, 7-mode composite emissions were computed using weighted factors. Table 29 shows the respective weighting factors used. As the number of modes decreases, each modal point represents more time in mode and a wider range of power; thus the weighting for each of the 7 modes must be increased compared to its factor for 13-mode use. For both the 13-mode and the 7-mode procedures, the idle condition accounts for 20 percent of the composite value (equivalent to 20 percent of operating time).

TABLE 29. LISTING OF 13-MODE AND 7-MODE WEIGHTING FACTORS

	13-Mode		7-Mode	
Mode	Engine Speed/Load, %	Wt. Factor	Mode	Wt. Factor
1	Idle	0.067		
2	Intermediate/2	0.080	1	0.12
3	Intermediate/25	0.080		
4	Intermediate/50	0.080	2	0.16
5	Intermediate/75	0.080		
6	Intermediate/100	0.080	3	0.12
7	Idle	0.067	4	0.20
8	Rated/100	0.080	5	0.12
9	Rated/75	0.080		
10	Rated/50	0.080	6	0.16
11	Rated/25	0.080		
12	Rated/2	0.080	7	0.12
13	Idle	0.067		
	Composite	1.000	Composite	1.00

Transient engine operation was performed in accordance with the 1984 Transient FTP for Heavy-Duty Diesel Engines.(2) The procedure specifies a transient engine exercise of variable speed and load, depending on the power output capabilities of the test engine. The cycle requires relatively rapid dynamometer control, capable of loading the engine one moment and motoring it the next. The system used in this program consisted of a GE 200 hp motoring/250 hp absorbing dynamometer coupled to a Midwest 500 hp eddy current (absorbing) dynamometer, with a suitable control system fabricated in-house.

The 1984 Transient cycle is described in the Federal Register by means of percent torque and percent rated speed for each one-second interval, over a test cycle of 1199 seconds duration. The 20-minute transient cycle, developed from heavy-duty truck data, is composed of four five-minute segments. The four segments are described below:

Transient Cycle Segment	Time, sec
New York Non-Freeway (NYNF)	297
Los Angeles Non-Freeway (LANF)	300
Los Angeles Freeway (LAF)	305
New York Non-Freeway (NYNF)	297

In order to generate the transient cycle for the test engine, the engine's full power curve was obtained from 400 rpm to maximum no load engine speed. Data from this "power curve," or engine map, were used in conjunction with the specified speed and load percentages to form the transient cycle. As an example, a graphic presentation of speed and torque commands which constituted an FTP transient cycle for a 250 hp diesel engine is given in Figure 11. For this example, the resulting cycle work was 11.68 kW-hr (15.66 hp-hr) based on a peak torque of 880 N•m (650 ft lbs) and a rated speed of 2200 rpm. The relatively large negative torque commands shown in the figure are to insure that the "throttle," or rack control, goes closed for motoring operation.

The two NYNF segments, which are the initial and final cycle segments of the transient cycle, together contain approximately 23 percent of the total reference work called for by the transient cycle. The LANF segment contains 20 percent and the LAF contains 57 percent of the total transient cycle reference work. This comparison illustrates that most of the work is produced during the LAF cycle segment.

The transient cycle is perceived as a lightly-loaded duty cycle. The average duty cycle over the entire transient cycle is approximately 20 percent of available engine power. The NYNF only calls for an average of 9 percent of the maximum power available from the engine; whereas the LANF calls for approximately 15 percent and the LAF requires about 45 percent. In addition, each NYNF segment contains 165 seconds of idle and 27 seconds of motoring, and LANF segment contains 98 seconds of idle and 79 seconds of motoring, and the LAF segment contains 11 seconds of idle and 45 seconds of motoring.

Of the 1199 seconds of the transient cycle, closed rack commands account for 617 seconds. Therefore, the engine must attempt to produce the reference cycle work within the remaining 582 seconds. These statistics mean that the engine has to produce an equivalent of 40 percent of its maximum power for the remaining "non-idle" time of cycle (582 seconds). These observations for the transient test stress the relative importance of pollutant emissions during idle, accelerations and medium- to light-load conditions.

A Transient FTP Test consists of a cold-start transient cycle and a hot-start transient cycle. The same engine control or command cycle is used in both cases. For the cold-start, the engine was operated over a "prep" cycle, then allowed to stand overnight in an ambient soak temperature of 20 to 30°C (68 to 86°F). The cold-start transient cycle begins when the engine is cranked for cold start-up. Upon completion of the cold-start transient cycle, the engine is shut down and allowed to stand for 20 minutes. After this hot soak period, the hot-start cycle begins with engine cranking.

All engines react somewhat differently to the transient cycle commands, due to both cycle and engine characteristics. In order to judge how well the engine follows the transient cycle command, engine responses are compared to engine commands using least squares regression techniques, and several statistics are computed. According to the Federal Register, the following regression line tolerances should be met:

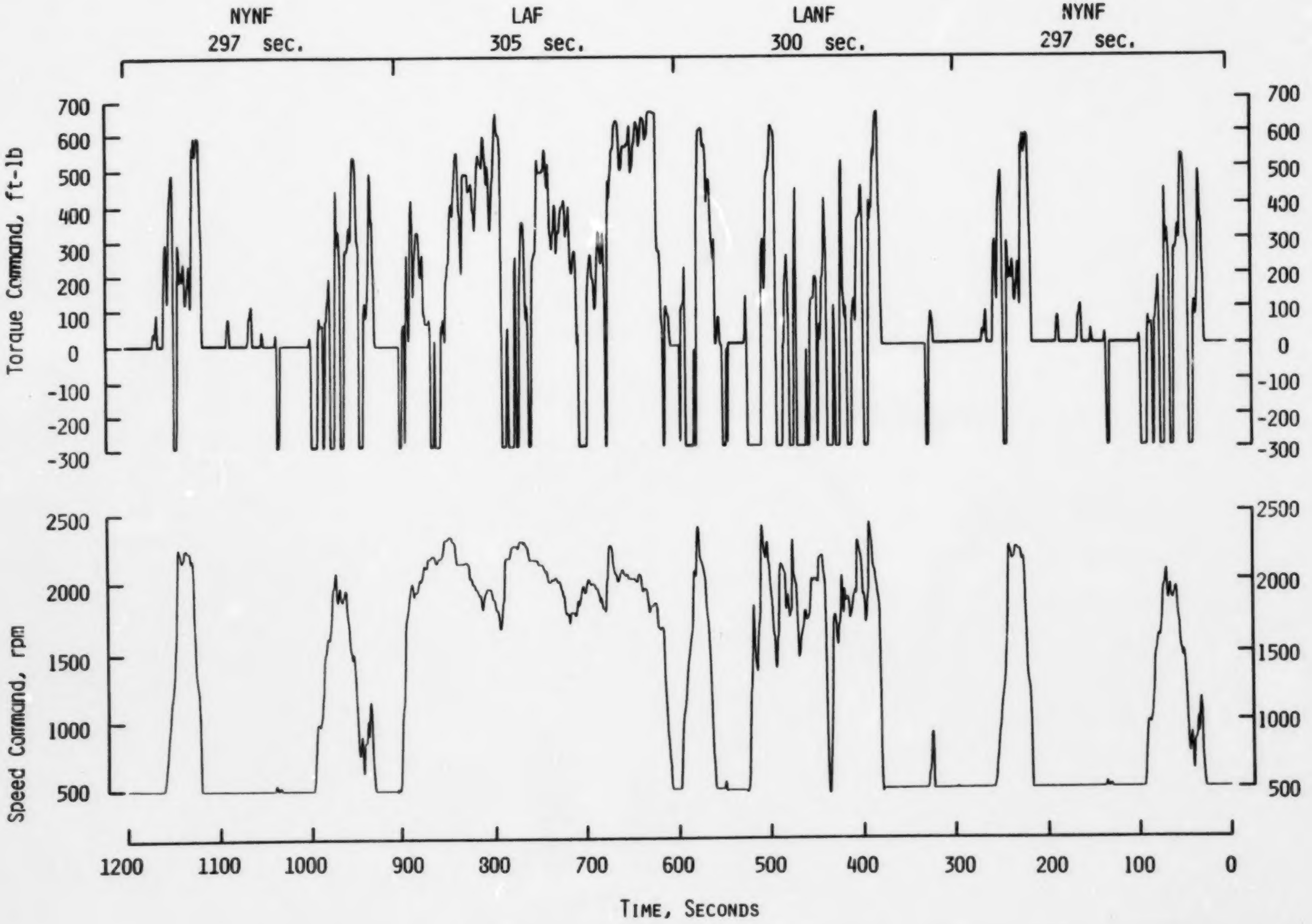

Figure 11. Graphic representation of torque and speed commands for the 1984 transient FTP cycle based on a diesel engine with rated speed of 2200 rpm with a peak torque of 650 ft-lbs

REGRESSION LINE TOLERANCES

	Speed	Torque	Brake Horsepower
Standard Error of Estimate (SE) of Y on X	100 rpm	13% of Maximum Engine Torque	8% of Maximum Brake Horsepower
Slope of the Regression Line, M	0.970 1.030	0.83-1.03 Hot 0.77-1.03 Cold	0.89-1.02 (Hot) 0.87-1.03 (Cold)
Coefficient of Determination, R^2	0.9700 1/	0.8800 (Hot) 1/ 0.8500 (Cold) 1/	0.9100 1/
Y Intercept of the Regression Line, B	±50 rpm	±15 ft lbs	±5.0 of brake horsepower

1/ Minimum

In addition to these statistical parameters, the actual cycle work produced should not be more than 5 percent above, or 15 percent below, the work requested by the command cycle.

If the statistical criteria are not met, then adjustments to throttle servo linkage, torque span points, speed span points, and gain to and from error feedback circuits can be made in order to modify both the engine output and the dynamometer loading/motoring characteristics. After completion of the cold-start and the hot-start transient cycles, transient composite emissions results are computed by the following:

$$\text{Brake Specific Emissions} = \frac{1/7\ (\text{Mass Emissions, Cold}) + 6/7\ (\text{Mass Emissions, Hot})}{1/7\ (\text{Cycle Work, Cold}) + 6/7\ (\text{Cycle Work, Hot})}$$

Similar to the 1984 Transient FTP cycle which was developed from heavy-duty truck data, a bus cycle was developed from CAPE-21 bus data.(15) The bus cycle was first introduced as a research test cycle during the heavy-duty diesel baseline test work. It was used in this program to indicate emission trends from the two engines in city bus applications. The 833 second transient bus cycle is composed of three segments, as shown below. A listing of the speed and torque cycle schedule is given in Reference 16. A graphic presentation of the speed and torque commands which constitute the bus is given in Figure 12. The resulting cycle work was 5.57 kW-hr (7.47 hp-hr) based on a peak torque of 880 N·m (650 ft lbs) at a rated speed of 2200 rpm. The bus cycle was run only as a hot-start test cycle, and was always preceded by a 20-minute soak.

Bus Cycle

Segment	Time, seconds
New York Combined	273
Los Angeles Combined	287
New York Combined	273

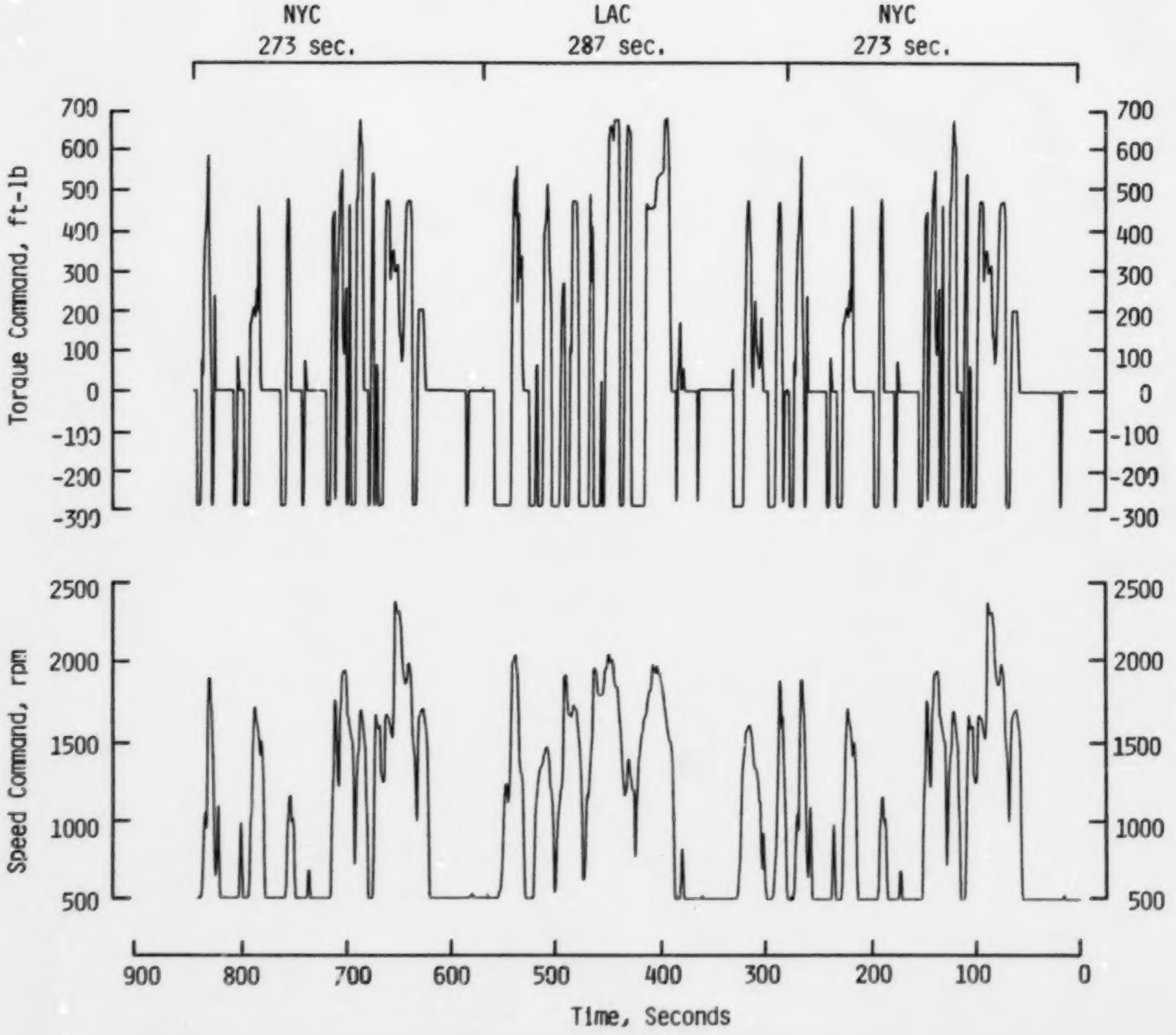

Figure 12. Graphic representation of torque and speed commands for the bus cycle based on a diesel engine with rated speed of 2200 rpm with a peak torque of 650 ft-lbs

The engine was also operated over the 1979 smoke FTP exercise.(17) It essentially consists of a 5-minute idle followed by full throttle acceleration to rated speed, and finally, a full throttle lug-down from rated speed to intermediate speed. This transient smoke test cycle was run only for the measurement of smoke emissions.

During steady-state or modal engine exercises, regulated and some unregulated gaseous emissions can be sampled from the raw exhaust stream since a representative and proportional sample can be obtained. Obtaining proportional samples during transient engine operation requires the use of a constant volume sample (CVS). Figure 13 shows the basic layout of the double-dilution CVS used to comply with the 1984 Transient FTP and the 1986 Proposed Transient FTP,(18) which includes the measurement of particulate. All transient cycle test work during this program was conducted with a main dilution tunnel flow set to provide approximately a 4:1 cycle dilution ratio of the total exhaust introduced. Regulated and unregulated gaseous emission samples were taken from the main dilution flow. Particulate-related samples required that a portion of the dilute exhaust from the main tunnel be diluted further, to an overall dilution of 12:1. The small double-dilution tunnel was operated at approximately 4 SCFM total flow in order to collect particulate on two 90 mm T60A20 Pallflex filters in series. Weight gains from these two filters were used to determine the total particulate mass emissions from the engine. The large double-dilution tunnel was operated at approximately 375 SCFM total flow, in order to accumulate large particulate samples on three 20 x 20 inch filters. It also provided auxiliary particulate sampling stations for smaller 47 mm filters. This same CVS system was used to collect particulate samples from steady-state operation of the two diesel bus engines, by altering the main dilution tunnel flow to accommodate the total exhaust from the engine without exceeding 52°C (125°F) at the particulate filter face.

2. Analytical Procedures

The analytical systems used for each category of emission measurements are described in this section. The section is divided into two parts, the first dealing with gaseous emissions characterization and the second with total particulate emissions and the constituents of the total particulate. Gaseous emissions included HC, CO, CO_2, NO_x, and some unregulated pollutants. Unregulated gaseous emissions included individual hydrocarbons, aldehydes, phenols, and odor. Particulate emissions included determination of the total particulate mass, and its content of sulfate, metals, carbon and hydrogen. The soluble organic fraction (SOF) of the total particulate was determined using methylene chloride. This soluble fraction was characterized for BaP content, bioactivity by the Ames test, boiling point distribution, and for carbon and hydrogen content.

a. Gaseous Emissions

Regulated gaseous emissions of HC, CO, and NO_x were measured according to the 1979 13-mode FTP and the 1984 transient FTP. The regulated emissions along with CO_2 were determined from raw exhaust samples taken during the 13-mode steady-state procedure. These same four constituents were determined in dilute exhaust samples taken during the

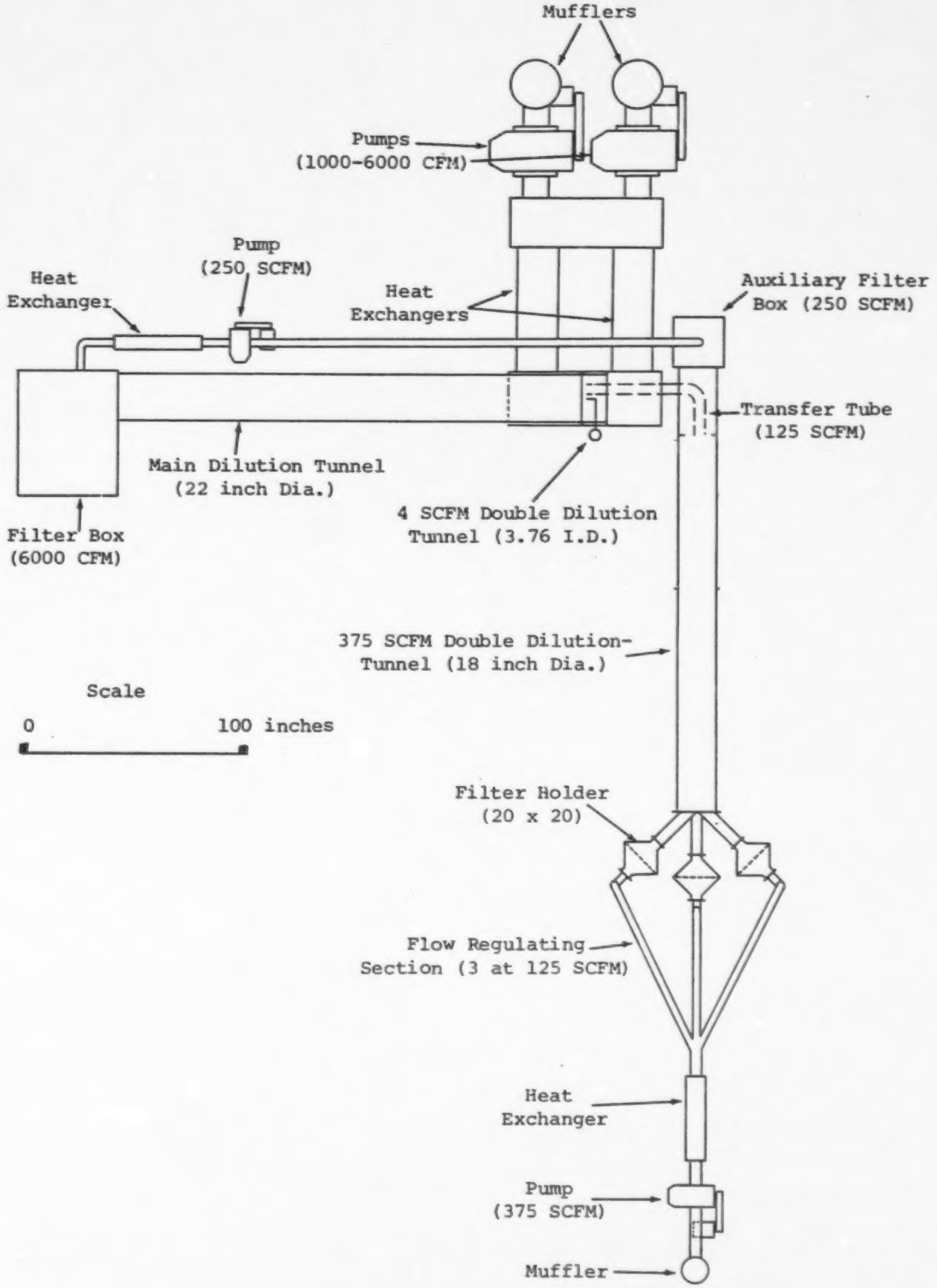
Mufflers
Pumps (1000-6000 CFM)
Pump (250 SCFM)
Heat Exchanger
Heat Exchangers
Auxiliary Filter Box (250 SCFM)
Transfer Tube (125 SCFM)
Main Dilution Tunnel (22 inch Dia.)
4 SCFM Double Dilution Tunnel (3.76 I.D.)
Filter Box (6000 CFM)
375 SCFM Double Dilution-Tunnel (18 inch Dia.)
Scale
0
100 inches
Filter Holder (20 x 20)
Flow Regulating Section (3 at 125 SCFM)
Heat Exchanger
Pump (375 SCFM)
Muffler

Figure 13. Basic layout of transient cycle heavy-duty diesel CVS with large double dilution sampler for three 20 x 20 filters

transient procedure. The transient procedure required that total HC be determined from integration of continuous concentration monitoring of the CVS dilute exhaust. The procedure provided the option of determining CO, CO_2, and NO_x from either dilute sample bags or from integration of continuous concentration monitoring.

Hydrocarbons were measured over both test procedures using the specified heated sample train (190°C). During steady-state operation, raw exhaust sample was transferred to a hydrocarbon instrument containing a Beckman 402 heated flame ionization detector (HFID) by heated sample line. During transient operation, CVS-diluted exhaust was taken from the main dilution tunnel using the prescribed heated probe and heated filter, and was transferred to the 402 HFID by heated sample line. The heated HC probe and overflow calibration technique was used in total HC measurements. Details as to the measurement of the requlated gaseous emissions may be found in Reference 1 for the 13-mode procedure, and in Reference 2 for the transient procedure. The intent of both procedures is to determine the "total" HC emissions from the engine under test.

Carbon monoxide was measured during both engine test procedures using non-dispersive infrared (NDIR) instruments. Emissions of CO_2 were also determined by NDIR for use in fuel consumption calculations by carbon balance. Both CO and CO_2 were determined from raw exhaust samples transferred by heated sample lines during the 13-mode procedure. During transient test procedures, CO and CO_2 levels were determined from proportional dilute exhaust bag samples.

NO_x emissions were determined by chemiluminescence (CL) from raw exhaust during steady-state operation, and from both dilute sample bags and integration of continuous NO_x concentration monitored during transient operation. The transient NO_x level determined from the bag sample has generally been lower (5-15 percent) than that indicated by continuous NO_x measurement techniques. No NO_x correction factor for intake humidity was applied for transient testing because the engine intake humidity and temperature were controlled to 60-90 grains/lb of dry air and 68-86°F.(2)

Some selected individual hydrocarbons (IHC) were determined from dilute exhaust samples using a CVS. Samples were taken over seven individual modes of steady-state operation and over the cold-start and hot-start transient cycles. A portion of the dilute exhaust sample collected in a Tedlar bag was injected into a four-column gas chromatograph using a single flame ionization detector and dual sampling valves.(10) The timed sequence selection valves allowed the baseline separation of air, methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene.

Aldehydes and ketones were determined by using the 2,4-dinitrophenylhydrazine (DNPH) method.(10) Raw exhaust samples were taken during steady-state operation; whereas dilute samples were taken from the main CVS dilution tunnel during transient testing. In both bases a heated sample line and filter were maintained at 190°C (375°F). The procedure consists of bubbling filtered exhaust gases, dilute or raw, through glass impinger traps containing a solution of DNPH and HCl kept at 0°C. The aldehydes and ketones (also known as carbonyl compounds) react with the DNPH to form their respective phenylhydrazone derivatives (precipitates). These derivatives are removed by filtration followed by pentane extractions evaporated in a vacuum oven. The remaining dried extract, which contains the phenylhydrazone derivatives, is dissolved in a specific volume of toluene with anthracene internal standard. A portion of this dissolved extract is injected into a gas chromatograph and analyzed using a flame ionization detector to separate formaldehyde, acetaldehyde, acetone, isobutyraldehyde, methylethylketone, crotonaldehyde, hexanaldehyde, and benzaldehyde.

Phenols, which are hydroxyl derivatives of aromatic hydrocarbons, were measured using an ether extraction procedure detailed in Reference 10. Raw exhaust samples were taken during steady-state operation, and dilute samples were taken from the main CVS dilution tunnel during transient operation. Exhaust samples were collected in impingers containing aqueous potassium hydroxide. The contents of the impingers were acidified with sulfuric acid, then extracted with ethyl ether. This extract was injected into a gas chromatograph equipped with an FID for the determination of various phenols as follows:

"Phenol"	Molecular Weight
Phenol	94.11
Salicyaldehyde	122.13
m-Cresol	108.15
p-Cresol	108.15
2,3-xylenol	122.17
3,5-xylenol	122.17
p-ethylphenol	122.17
2-isopropylphenol	136.20
2,4,5-trimethylphenol	136.20
2,3,5-trimethylphenol	136.20
2,3,5,6-tetramethylphenol	150.22

At the start of the program, both filtered and unfiltered exhaust samples were analyzed. The unfiltered exhaust samples appeared to indicate the same trends but with lower response than obtained using a filtered sample. The unfiltered exhaust sample was dropped in favor of the filtered exhaust sample on the basis of better recovery.

Total intensity of aroma (TIA) was quantified by using the Coordinating Research Council Diesel Odor Analytical System (DOAS).(9) The dilute or raw sample, depending on engine operation, was drawn off through a heated sample train and into a trap containing Chromosorb 102. The trap was later eluted and injected by syringe into the DOAS instrument, which is a liquid chromatograph that separates an oxygenate fraction (liquid column oxygenates, LCO) and an aromatic fraction (liquid column aromatics, LCA). The TIA values are defined as $\text{TIA} = 1 + \log_{10}(\text{LCO}, \mu g/\ell)$ or $\text{TIA} = 0.4 + 0.7 \log_{10}(\text{LCA}, \mu g/\ell)$ (TIA by LCO preferred). A.D. Little, the developer of the DOAS instrument, has related this fraction to TIA sensory measurement by the A.D. Little odor panel. The system was intended for raw exhaust samples from steady-state operating conditions, but for this program, dilute samples of exhaust were taken in order to determine a TIA value for transient operation. Where dilute samples were taken, the corresponding TIA values were increased proportional to the dilution ratio.

b. Particulate Emissions

Particulate emissions were determined from dilute exhaust samples utilizing various collection media and apparatus, depending on the analysis to be performed. Particulate has been defined as any material collected on a fluorocarbon-coated glass fiber filter at or below a temperature of 51.7°C (125°F), excluding condensed water. The 125°F temperature limit and the absence of condensed water dictates that the raw exhaust be diluted, irrespective of engine operating mode. The temperature limit generally required dilution ratios of approximately 12:1 (total mixture:raw exhaust).

Total particulate samples were collected on 90 mm Pallflex T60A20 fluorocarbon-coated glass fiber filter media by means of a double-dilution technique for both transient and steady-state engine operation. Gravimetric weight gain, representing collected particulate, was determined to the nearest microgram after the filter temperature and humidity were stabilized. This weight gain, along with CVS flow parameters and engine data, were used to calculated the total particulate mass emission of the engine under test.

Smoke and total particulate are related in that the relative level of smoke opacity indicates the relative level of particulate. The absence of smoke, however, does not indicate the absence of particulate. Smoke was determined by the end-of-stack EPA-PHS smokemeter which monitored the opacity of the raw exhaust plume as it issued from the exhaust pipe. Smoke opacity was determined for the 13-mode operation, power curve operation, and for the smoke FTP.

Since total particulate, by definition, includes anything collected on fluorocarbon-coated glass fiber filter media, there has always been an interest to find out what constitutes the "total particulate." The following paragraphs describe the methods and analysis used to determine some of the properties of the total particulate.

Sulfate, originating from the combustion of sulfur-containing fuel, was collected as part of the particulate matter in the form of sulfate salts or sulfuric acid aerosols. A 47 mm Fluoropore (Millipore Corp.) fluorocarbon membrane filter with 0.5 micron pore size was used to collect the sample. This total particulate sample is ammoniated to "fix" the sulfate portion of the particulate. Using the barium chloranilate (BCA) analytical method,(10) the sulfates are leached from the filter with an isopropyl alcohol - water solution (60% IPA). This extract is injected into a high pressure liquid chromatograph (HPLC) and pumped through a column to scrub out the cations and convert the sulfate to sulfuric acid. Passage through a reactor column of barium chloranilate crystals precipitates out barium sulfate and released the highly UV absorbing chloranilate ions. The amount of chloranilate ion released is determined by a sensitive liquid chromatograph UV detector at 310-313 nanometers. "Sulfate" should be understood to mean $SO_4^=$ as measured by the BCA method.

Carbon, hydrogen, metals, and other elements that make up the total particulate are also of interest. A sample of "total particulate" was collected on 47 mm Type A (Gelman) glass fiber filter media for the purpose of determining the carbon and hydrogen weight percentages. This analysis was performed by Galbraith Laboratories using a Perkin-Elmer Model 240B automated thermal conductivity CHN analyzer. This instrument was designed for analysis of liquid samples. In order to accommodate the particulate sample on a filter, the filter must be folded or rolled over itself. As the temperature is increased, the glass fiber media collapses on itself, sometimes locking in some of the particulate. For this reason significant inaccuracies can occur. One of the ways to improve the accuracy was to collect relatively high particulate loadings. This was possible for steady-state operation but difficult for transient testing.

A sample of total particulate matter was also collected on a 47 mm Fluoropore filter for the determination of trace elements such as calcium, aluminum, phosphorus, and sulfur by x-ray fluorescence. This analysis was conducted at the EPA, ORD Laboratories in Research Triangle Park, N.C. using a Siemens NRS-3 x-ray fluorescence spectrometer.

Carbon has long been recognized as an excellent adsorbing medium for hydrocarbon aerosols. Similarly, it has been recognized that carbonaceous particulate could readily adsorb hydrocarbons present in the exhaust. In order to determine to what extent total particulate contains these various hydrocarbons, particulate filter samples were washed with an organic solvent, methylene chloride. The dissolved portion of the "total particulate" carried off with the methylene chloride solvent has been referred to as the "soluble organic fraction" (SOF). As with total particulate, the SOF may be composed of anything carried over by the extraction process, so its composition is also of interest. Generally, the SOF contains numerous organic compounds, many of which are difficult to isolate and the quantify. Some SOF has been shown to be mutagenic using the Ames test.

Relatively large amounts of soluble organic fraction (some 300 mg) are generally needed for elemental characterization and Ames testing. Large 500 x 500 mm (20 x 20 inch) Pallflex filters were used to collect corresponding large amounts of total particulate for extraction. As mentioned earlier, both CVS units used in this program can collect three 20 x 20 particulate samples simultaneously. These filters are weighed to determine the particulate loading, then stored in glassine bags within a brown paper envelope. Several of these envelopes are grouped and sealed in a Tedlar bag purged with nitrogen. The Tedlar bags are then stored in a freezer until needed for extraction. These steps generally take place within a few hours of sample collection, and are carried out under yellow light (ultraviolet light filtered out using Kodak "yellow chrome II" film).(19)

When specific total particulate samples were selected for extractions, the corresponding filters were pulled from freezer storage for extraction. After adequate cycling time, the solvent (methylene chloride) containing the extractables was filtered, then evaporated to "dryness" in a preweighed vial using blown-in nitrogen. The weight of the "dried" extract was determined, and the SOF percent of total particulate calculated. "Dried" refers to the complete removal of the solvent. The vial contents were either distributed for analysis or stored in the freezer for subsequent analysis or shipment. As with filter handling, all extraction steps were carried out under yellow light.

Carbon, hydrogen, sulfur, and nitrogen were determined for the SOF. Carbon and hydrogen content of the "dried" extract was determined by Galbraith Laboratories using a Perkin-Elmer Model 240B automated thermal conductivity CHN analyzer. A portion of the extract was submitted to SwRI's Mobile Energy Division for nitrogen analysis by chemiluminescence and sulfur analysis by x-ray fluorescence.

The boiling range of the SOF was determined by SwRI's Mobile Energy Division using a high-temperature variation of ASTM-D2887-73. Approximately 50 mg of the SOF was dissolved in solvent and an internal standard (C_9 and C_{11} compounds) was added. This sample was then submitted for instrumental analysis of boiling point distribution.

BaP is considered to be an elementary indicator of the relative PNA content of the SOF. The analytical method used for the determination of BaP is described in Reference 20. The procedure is based on high-performance liquid chromatography to separate BaP from other organic solubles in particulate matter, and it incorporated fluorescence detection to measure BaP. The instrument used was a Perkin-Elmer 3B liquid chromatograph equipped with a MPF-44 fluorescence spectrophotometer. Excitation was at a wavelength of 383 nm, and emission was read at 430 nm.

As mentioned earlier, there is concern about the potential health effects impact that diesel exhaust may have. The emphasis of this concern has been placed on the SOF which was submitted for Ames testing.

The Ames test, as employed in this program, refers to a bacterial mutagenesis plate assay with Salmonella typhimurium according to the method of Ames. This bioassay determines the ability of chemical compounds or mixtures to cause mutation of DNA in the bacteria, positive results occurring when histidine-dependent strains of bacteria revert (or ar mutated) genetically to forms which can synthesize histidine on their own. Samples of SOF were shipped under dry ice to EG&G* for Ames test response. Details of this procedure can be found in References 19 and 21.

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*EG&G Mason Research, Inc. is now Microbiological Associates, Inc., 5221 River Road, Bethesda, Maryland 20816. These analyses were done under a separate EPA Contract (68-03-2923).

Efforts to set-in the planned maladjustment on this engine were begun on February 21, 1980. The proposed maladjustment consisted of increasing the injector lash by 0.002 inch from the standard setting of 0.187 ± 0.001, and reducing the turbocharger boost pressure of about 20 in. Hg by 4 in. Hg at the maximum power condition.

Increasing the injector lash was intended to simulate a worn camrocker assembly or maladjustment of injector lash, which would prevent the injector plunger from seating to the bottom of the injector cavity and contribute to nozzle leakage, thereby affecting smoke and gaseous emissions. A dial indicator, as prescribed by the manufacturer's injector lash adjustment procedure, was used to adjust the injector lash. Prior to maladjustment, the average injector lash was determined to be 0.1887 inch with a standard deviation of 0.0006 inch. Injector lash of each cylinder was increased by 0.002 inch from its baseline measurement.

Reducing the boost pressure was intended to simulate a hose connection failure on the boost air duct, or a malfunctioning turbocharger. In order to induce a controlled bleed of the boost pressure, a 1-inch gate valve was installed on the 1-inch pipe port normally used to supply filtered boost air to the auxiliary air compressor. Air vented through the gate valve was returned to the intake air supply, between the damper used to set intake restriction and the laminar flow element used to measure intake air during the 13-mode FTP. The engine was run at maximum power with the boost bleed closed, restrictions were set, and the boost pressure noted. The boost bleed gate valve was opened to obtain a 4 in. Hg reduction in the measured boost pressure. Once the boost bleed was adjusted, intake and exhaust restrictions were allowed to vary as shown below:

	13-Mode Restrictions	
	Intake, in. H_2O	Exhaust, in. Hg
Baseline	25.	3.0
Maladjusted	25.	2.5

	Transient Restrictions	
	Intake, in. H_2O	Exhaust, in. Hg
Baseline	10.	2.0
Maladjusted	10.	1.6

With the combined maladjustment of 0.002 inch injector lash on all eight injectors and the 4 in. Hg reduction of the boost pressure, the engine was operated at the same power levels as the baseline configuration. Relatively minor changes in smoke opacity and gaseous emissions were noted during steady-state operation with this preliminary maladjusted configuration. The Project Officer was consulted. It seemed that these preliminary maladjustments were not severe enough to cause noticeable changes in smoke or gaseous emissions on a steady-state basis. It was decided to increase the injector lash by an additional 0.002 inch, making the average injector lash 0.1928 inches.

Gaseous emissions and smoke were monitored during steady-state operation at maximum power, maximum torque, idle, and 2 percent load conditions. Hydrocarbons almost doubled, and CO increased by about a factor of 1.5. Smoke opacity at the maximum torque condition increased from about 1.6 to 3.0 percent, still invisible to the human eye. Smoke FTP cycles were run using the in-line smokemeter and using the same control tape as used for the baseline engine. The results from these tests are given below:

Configuration	Federal Transient Smoke Cycle Smoke Opacity, %		
	"A"	"B"	"C"
Baseline	4.4	2.6	5.4
Maladjusted	7.1	3.2	9.4

Although there was only a minor change in the lug factor ("B"), the second maladjustment caused significant increases in the acceleration and peak factor smoke opacities. Both the maximum power and the maximum torque conditions were run for particulate samples. Preliminary results from these particulate filters indicated that the particulate rate increased by about 65 percent at these conditions as a result of the latest maladjustment combination. Based on these results, it was assumed that a detectable change in emissions had occurred from the combination of 0.004 inch additional injector lash (from baseline configuration) and a 4 in. Hg reduction of boost pressure (set at maximum power). This maladjusted configuration was approved by the Project Officer on February 26, 1980.

2. Emissions Tests Results

After completing emission characterization of the Cummins VTB-903 engine in the baseline configuration, the engine was maladjusted by increasing the injector lash by 0.004 inch from the standard setting of 0.187 ± 0.001 and by reducing the boost pressure of about 20 in. Hg by 4 in. Hg (at maximum power conditions). Samples for maladjusted emission characterization were taken in the same manner as for the baseline emission characterization.

In order to simulate a driver demanding the same work load from the maladjusted engine as from the baseline engine configuration, the baseline transient control tape was used with the maladjusted engine. The baseline engine power map used to generate the transient cycle control tape is given in Table B-1 of Appendix B. In a similar approach, 13-mode emissions for the maladjusted configuration were run at the same load conditions used for the baseline configuration. Maladjustment reduced the maximum power by approximately 1 percent and reduced the maximum torque by about 4.5 percent.

The transient test procedure was run with the engine on a stationary dynamometer with the total exhaust transferred to a double dilution CVS, and primary dilution at a nominal flow rate of 2000 CFM. Transient cycle particulate emissions were determined via a 4 CFM (total flow) secondary dilution system using 90 mm Pallflex filters. Auxiliary samples for sulfate, metals, and organic extract were taken via a 375 CFM (total flow) secondary dilution system using 47 mm Fluoropore and 20 x 20 Pallflex filters. Transient cycle gaseous emissions of CO and CO_2 were determined from proportional bag samples of the primary dilution flow. Integrations of individual analyzer outputs were used to determine the emissions of HC and NO_x. Transient cycle unregulated gaseous emissions of aldehydes, odor, phenols and individual hydrocarbons were determined from proportional samples of the CVS primary dilution flow.

Modal (or steady-state) engine exercises were run on the same stationary dynamometer. Gaseous emissions of HC, CO, NO_x were determined using the 13-mode FTP. Similarly, unregulated gaseous emissions were determined from raw exhaust samples over 11, 7, or 5 modes of steady-state operation. To determine modal emissions of particulate and sulfate, total raw exhaust was transferred to the CVS. Due to he wide variation in load, idle to maximum power, the CVS nominal flow rate was changed in order to preserve the 125°F temperature limit for particulate collection without overdiluting. Primary CVS flow of about 1000 CFM was used for idle and 2 percent load conditions, 2000 CFM for 25 and 50 percent load, and 4000 CFM for 75 and 100 percent load. Secondary dilution flow remained the same. Replicate 20 minute runs were made in order to improve accuracy of results and to insure that enough particulate matter was collected for organic extraction.

In comparing data following the release of the engine (March 4, 1980), it was discovered that an error in computed load occurred at the 25 and 75 percent power points at rated speed. The actual loads used for these two points were 17 percent and 67 percent of full power at rated speed (based on baseline configuration). Since results are reported on brake specific and fuel specific basis, this error should not affect the results appreciably.

A summary of 13-mode and transient test composite emission rates of regulated gaseous emissions is given in Table 30 on a brake specific basis. Examining the 13-mode results, maladjustment increased HC by a factor of 4.1 and increased CO by 1.6 times, with no change in NO_x. Maladjusted transient test composite results showed increases in HC and CO emissions by factors of 3.9 and 1.7, respectively, and showed a trend toward reduced NO_x. These relative changes in composite gaseous emissions are illustrated in Figure 15. Tables B-2 and B-3 of Appendix B also give detailed gaseous emissions information from transient cycles and 13-mode tests run in baseline and maladjusted configurations. Examining the cold-start transient test results indicates that this engine was somewhat cold-start sensitive in both configurations.

Even though both 13-mode and transient procedures indicated the same trends, the levels of emissions of HC, CO, and NO_x were different. Transient test HCs were about 1.8 times higher than the 13-mode procedure, but transient CO was only about 90 percent of modal CO. Transient NO_x was about 85 percent of modal NO_x. Transient BSFC was about 6 percent higher than 13-mode BSFC. The maladjustment increased BSFC by 6 percent for the steady-state FTP and by 7 percent for the transient FTP. There was about a 3 percent loss in maximum power observed with the maladjustment.

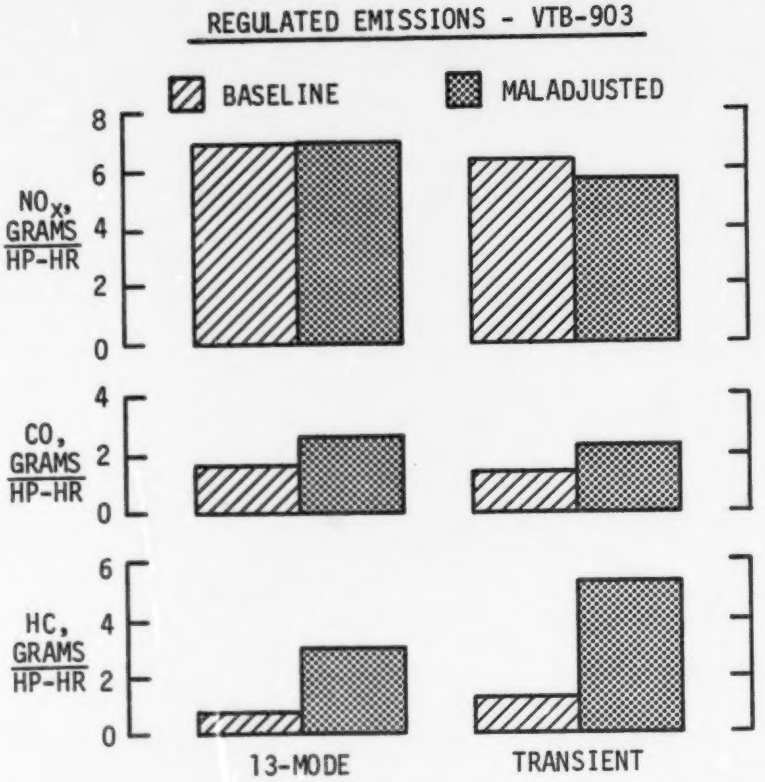

Figure 15. Composite gaseous emissions of the Cummins VTB-903 in baseline and maladjusted configurations

TABLE 30. COMPOSITE RESULTS OF REGULATED GASEOUS EMISSIONS FROM CUMMINS VTB-903 RUN IN BASELINE AND MALADJUSTED CONFIGURATIONS

Engine Configuration	Cycle	Run No.	Emission Rate, g/kW-hr HC	CO	NO_x	$HC+NO_x$	BSFC, kg/kW-hr
Baseline	13-Mode Composite	1	0.944	2.412	0.224	10.169	0.254
		2	0.969	1.988	9.352	10.321	0.254
		Avg	0.957	2.200	9.288	10.245	0.254
Maladjusted	13-Mode Composite	1	3.821	4.005	9.134	12.955	0.268
		2	4.055	3.084	0.360	13.415	0.270
		Avg	3.938	3.545	9.247	13.185	0.269
Baseline	Transient Composite	1	1.87	1.88	8.48	10.35	0.270
		2	1.72	1.81	8.47	10.19	0.269
		3	1.79	1.92	6.55[a]	8.34	0.268
		Avg	1.79	1.87	7.83	9.63	0.269
					8.48[b]	10.27[b]	
Maladjusted	Transient Composite	1	6.49	3.12	7.27[a]	14.21	0.280
		2	7.01	3.12	7.99[a]	15.00	0.295
		Avg	6.98	3.12	7.63	14.61	0.288

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[a] There is some doubt about the integrity of the NO_x integration hardware for this run

[b] Average value is based on runs 1 and 2

In addition to total HC emission measurements, representative gaseous samples from selected modes of the steady-state and transient procedures were processed using gas chromatographic techniques to distinguish specific individual hydrocarbons. Instrumentation was set to separate and quantify methane, ethylene, ethane, acetylene, propane, propylene, benzene, and toluene. A summary of total individual hydrocarbons measured is given in Table 31 for various operating conditions. Tables B-4 through B-6 of Appendix B give detailed information on emissions of various species of hydrocarbons found.

For the Cummins VTB-903 in the baseline configuration, most of the above-mentioned hydrocarbon species (except propane) were present in relatively minor concentrations at the idle and 2 percent power conditions. Fewer species and lesser concentrations of those present were noted over the other steady-state modes. Modal data indicated that maladjustment significantly increased emission of most individual hydrocarbons, especially toluene and benzene. Some chromatographic interference appeared to be present which made it difficult to reliably assess the amount of toluene and benzene.

TABLE 31. SUMMARY OF INDIVIDUAL HYDROCARBONS FROM THE CUMMINS VTB-903 IN BASELINE AND MALADJUSTED CONFIGURATIONS

Test Condition rpm/% load	Total Individual Hydrocarbons, Modal			
	Baseline		Maladjusted	
	mg/kW-hr	mg/kg fuel	mg/kW-hr	mg/kg fuel
1500/2	3667	1645	6303	3309
1500/50	18	76	116	481
1500/100	22	106	349	1449
Idle	--	1287	--	3009
2100/100	34	157	474	1990
2100/50	57	218	290	1030
2100/2	2295	1259	6406	2286
7-mode Composite	82	300	420	1530
	Total Individual Hydrocarbons, Transient			
Cold-Start	148	523	321	1080
Hot-Start	96	358	302	1060
Transient Composite	103	382	304	1060

The maladjustment of the VTB-903 increased the composite 7-mode total composite emissions of "individual hydrocarbons" from 82 to 420 mg/kW-hr. Of the eight species indicated, ethylene and propylene were predominant for all the seven selected modes of steady-state operation. Ethylene and propylene were nearly tripled at steady-state 2 percent load and idle conditions with the maladjustment.

For transient testing of the VTB-903 in maladjusted configuration, the level of ethylene and propylene was almost triple the level obtained during baseline testing. The transient FTP composite of individual hydrocarbons changed from 103 to 304 mg/kW-hr with maladjustment. In either configuration, ethylene accounted for approximately 62 percent, and propylene accounted for approximately 32 percent, of the total individual hydrocarbons measured (fuel or brake specific basis) during transient testing.

Aldehydes were also of interest as part of the total hydrocarbon measurements (often the HFID response to aldehydes is minimal) because they are associated with eye and lung irritation and other possible health effects problems. Aldehyde emissions from baseline and maladjusted configurations of the VTB-903 during both steady-state and transient operation are summarized in Table 32. More detailed aldehyde information may be found in Tables B-7 through B-9 of Appendix B.

TABLE 32. SUMMARY OF TOTAL ALDEHYDES FROM THE CUMMINS VTB-903 BASELINE AND MALADJUSTED CONFIGURATION

Test Condition rpm/% load	Total Aldehydes, Modal			
	Baseline		Maladjusted	
	mg/kW-hr	mg/kg fuel	mg/kW-hr	mg/kg fuel
1500/2	45	20	75	40
1500/50	9	36	24	102
1500/100	10	42	5	20
Idle	--	330	--	2256
2100/100	100	41	53	221
2100/50	7	27	69	243
2100/2	637	350	3031	1079
7-Mode Composite	13	50	66	241
	Total Aldehydes, Transient			
Cold-Start	234	825	89	300
Hot-Start	78	294	101	353
Transient Composite	101	369	99	345

Formaldehyde, acetaldehyde, and benzaldehyde were prevalent over transient operation of the VTB-903 in the baseline configuration. These species, along with isobutyraldehyde, were mostly found at the 2 percent load/rated speed and idle steady-states in the baseline configurations. For transient FTP operation in the maladjusted configuration, benzaldehyde and acetaldehyde were reduced somewhat, while formaldehyde increased such that the composite level of aldehyde emissions remained at about 100 mg/kW-hr. Total aldehydes from the maladjusted cold-start were about half those for baseline cold-start; but maladjusted hot-start aldehydes were slightly higher than baseline, hence the transient composites were very close. For steady-state operation in the maladjusted configuration, levels of all aldehyde species tended to increase at most of the conditions tested, causing the 7-mode aldehyde level to increase from 13 to 66 mg/kW-hr.

Phenols, which are hydroxyl derivatives of aromatic hydrocarbons, were determined using a wet chemistry procedure along with a gas chromatograph to separate phenol species ranging in molecular weight from 94.11 to 150.22. Phenols have been summarized in Table 33, showing the totals of the various species of phenols detected over 5 modes of steady-state operation and transient testing. Individual phenol information is presented in Tables B-10 through B-12 of Appendix B.

TABLE 33. SUMMARY OF PHENOLS FROM THE CUMMINS VTB-903 BASELINE AND MALADJUSTED CONFIGURATION

Test Condition rpm/% load	Total Phenols, Modal			
	Baseline		Maladjusted	
	mg/kW-hr	mg/kg fuel	mg/kW-hr	mg/kg fuel
1500/2	175	78.7	0	0
1500/50	0	0	0	0
Idle	--	49.9	--	425
2100/100	0	0	151	633
2100/50	0.1	0.2	14.6	52.8
	Total Phenols, Transient			
Cold-Start	15.9	56.2	14.5	48.8
Hot-Start	15.3	57.8	9.5	32.8
Transient Composite	15.4	57.6	10.2	28.1

For the VTB-903 baseline configuration, several species of phenols were noted at 2 percent load/intermediate speed and (in smaller amounts) at idle. In the maladjusted configuration, no phenols were noted at the 2 percent load/intermediate speed condition; but there were significant increases in phenols at idle and rated speed, 50 and 100 percent load conditions. Although modal data indicated an increase in phenol production, dilute samples from transient testing indicated the opposite. Transient brake specific levels of phenols for the baseline and maladjusted configurations of the VTB-903 were 15 and 10 mg/kW-hr, respectively.

Total intensity of aroma (TIA) was quantified using the CRC's diesel odor analysis system (DOAS). TIA results from DOAS are summarized in Table 34. As mentioned earlier, samples for DOAS, as well as other unregulated gaseous emissions, were taken from dilute exhaust during transient testing; whereas modal samples were taken from raw exhaust. The 7-mode composite values for the VTB-903 were 1.58 and 1.74 for the baseline and maladjusted configurations, respectively.

The transient composite indicated that TIA almost doubled from 0.69 to 1.05 due to the maladjustment. It is difficult to state that this relatively large change is real. No change in TIA was noted for the maladjusted cold-start transient cycle, although a slight increase in LCA was observed. TIA results from the maladjusted hot-start transient were very erratic. If the data from the second hot-start for both baseline and maladjusted testing were eliminated, the composite TIA for the maladjusted configuration would have increased from 1.17 to 1.32 (13 percent), which is in closer agreement with the 10 percent increase noted in 7-mode composite TIA results.

TABLE 34. SUMMARY OF DOAS RESULTS FROM CUMMINS VTB-903 IN BASELINE AND MALFUNCTION CONFIGURATIONS

Transient Cycle	Run No.	Baseline Configuration			Malfunction Configuration		
		LCA µg/ℓ	LCO µg/ℓ	TIA	LCA µg/ℓ	LCO µg/ℓ	TIA
Cold Start	1	9.95	2.27	1.36	8.28	2.35	1.37
	2	5.69	1.63	1.21	11.82	1.48	1.16
	Avg	7.82	1.95	1.29	10.05	1.92	1.27
Hot Start	1	5.54	1.38	1.15	8.09	2.13	1.33
	2	1.03	0.29	0.37	5.29	0.48	0.68
	Avg	3.29	0.84	0.59	6.69	1.31	1.01
Transient Composite		3.94	1.00	0.69	7.17	1.40	1.05
Transient Composite[a]		5.87	1.46	1.17	8.37	2.10	1.32

Steady State Mode	Test Condition rpm/% load	Baseline Configuration			Malfunction Configuration		
		LCA µg/ℓ	LCO µg/ℓ	TIA	LCA µg/ℓ	LCO µg/ℓ	TIA
1	1500/2	18.51	8.05	1.91	0.77	0.62	0.78
2	1500/50	8.66	3.91	1.60	31.57	5.37	1.73
3	1500/100	3.02	2.41	1.38	22.60	7.21	1.86
4	Idle	12.75	4.01	1.60	33.97	7.49	1.87
5	2100/100	7.00	3.92	1.59	34.90	11.96	2.08
6	2100/50	5.47	2.63	1.42	38.13	8.08	1.91
7	2100/2	9.45	3.61	1.56	38.49	6.58	1.82
7-Mode Composite		9.37	4.01	1.58	29.56	6.81	1.74

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[a] Based on average of both cold-starts and only the first hot-start value

One of the objectives of this work was to characterize the gaseous and particulate emissions associated with an engine producing "smoky" exhaust. Changes in smoke opacities from the baseline to maladjusted configurations were used in evaluating whether or not the maladjustment changes could simulate a smoky engine. Results from the FTP for smoke are given in Table 35, along with smoke opacity data from the 13-mode engine operation. The relative changes in smoke opacity are also illustrated in Figure 16.

Modal and power curve smoke were very low for both the baseline and maladjusted configurations. Maladjustment increased modal smoke opacities at the 2% load/intermediate speed, at the maximum torque condition, and somewhat at the maximum power condition. Even though smoke opacity was increased due to the maladjustments, the smoke opacities were still near or below the visible limit.

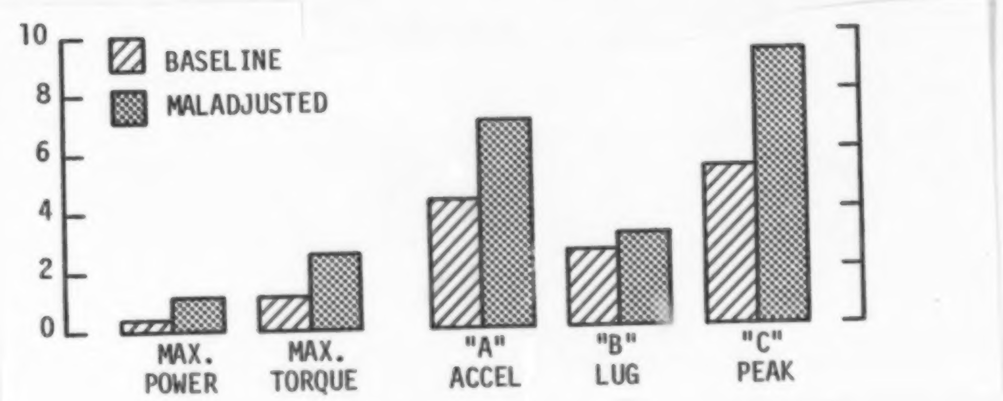

Figure 16. Smoke opacities from the Cummins VTB-903 in baseline and maladjusted configurations

Since smoke and total particulate are related in that the relative level of smoke opacity indicates the relative level of particulate, the maladjustments were expected to cause significant changes in the total particulate emission levels as well as change the character of the particulate emitted. The total particulate consists of many substances. Sulfate emissions are also collected as total particulate.

Table 36 gives composite particulate and sulfate results from 13-mode and transient test procedures for both baseline and maladjusted configurations. Figure 17 and 18 show particulate emissions versus percent of power at intermediate and rated speeds. Transient results are also indicated for comparison. In addition, Figure 16 indicated the relative modal and transient emissions of sulfate. Modal particulate data are given in Tables B-13 and B-14 of Appendix B. Modal sulfate data are given in Tables B-15 and B-16. Details regarding the computation of the modal composites of particulate and sulfate emissions are given in Tables B-17 and B-18 for the baseline and maladjusted configurations, respectively. A summary of transient sulfate emissions is given in Table B-19 of Appendix B (transient particulate emissions are given on the original computer printouts given in Tables B-2 and B-3).

TABLE 36. COMPOSITE PARTICULATE AND SULFATE RESULTS FROM CUMMINS VTB-903 IN BOTH BASELINE AND MALADJUSTED CONFIGURATIONS

		Brake Specific		Fuel Specific	
Cycle	Engine Configuration	Particulate g/kW-hr	Sulfate mg/kW-hr	Particulate mg/kg fuel	Sulfate mg/kg fuel
13-Mode Composite	Baseline	0.32	39.5	1.23	153
	Maladjusted	0.57	33.3	2.08	122
Transient Composite	Baseline	0.51	38.4	1.90	139
	Maladjusted	1.08	33.4	3.75	116

TABLE 35. SMOKE OPACITY FROM THE CUMMINS VTB-903 IN BASELINE AND MALADJUSTED CONFIGURATIONS

Federal Transient Smoke Cycle Opacity

	Smoke Opacity, %		
Configuration	"A"	"B"	"C"
Baseline	4.4	2.6	5.4
Maladjusted	7.1	3.2	9.4

Steady-State Smoke Opacity

13-Mode FTP			Smoke Opacity, %	
Mode	RPM	Power, %	Baseline	Maladjusted
1	Idle	--	0.8	1.2
2	1500	2	0.6	1.0
3	1500	25	1.1	1.5
4	1500	50	0.9	1.2
5	1500	75	0.7	1.1
6	1500	100	1.6	2.9
7	Idle	--	1.0	0.8
8	2100	100	0.6	1.1
9	2100	75	0.5	1.0
10	2100	50	0.6	1.0
11	2100	25	1.1	1.3
12	2100	2	1.0	1.0
13	Idle	--	0.5	0.9

Power Curve Smoke

	Smoke Opacity, %	
rpm	Baseline	Maladjusted
2100	0.2	1.2
1900	0.3	1.7
1700	0.7	2.1
1500	0.9	2.3
1400	---	2.4

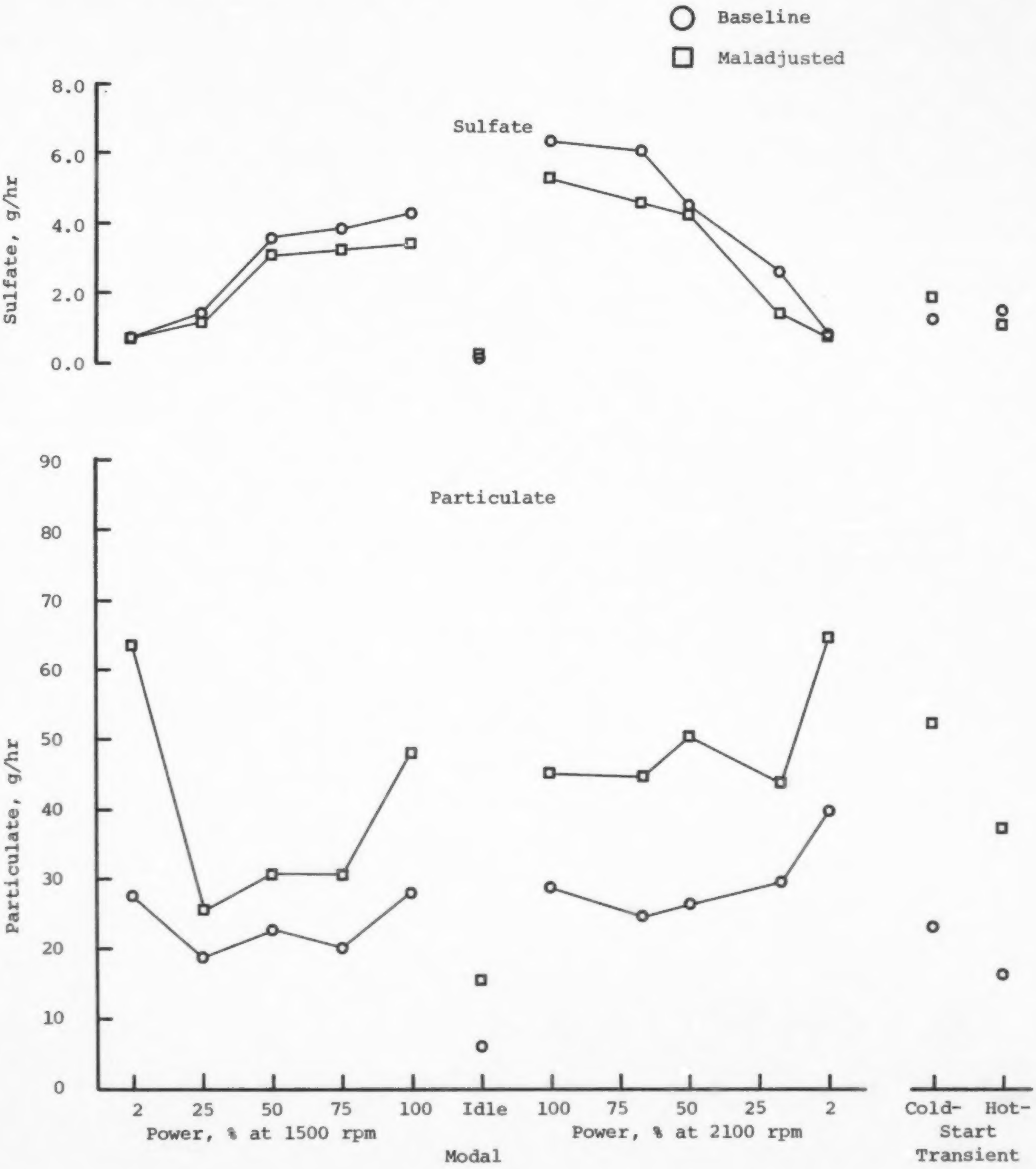

Figure 17. Particulate and sulfate rates from Cummins VTB-903 in baseline and maladjusted configurations

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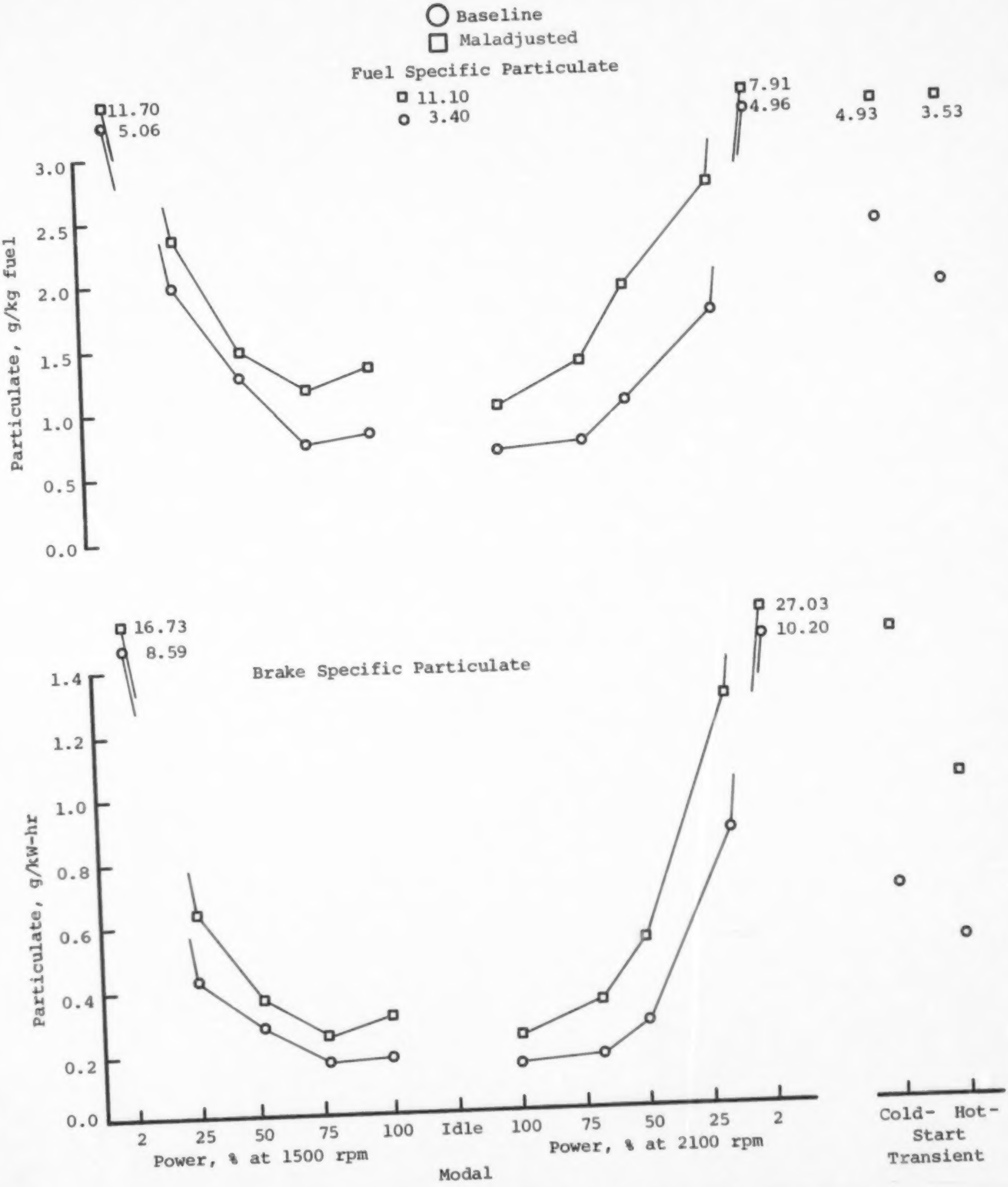

Figure 18. Brake and fuel specific particulate from Cummins VTB-903 in baseline and maladjusted configurations

The maladjustment increased particulate emission levels from the VTB-903 for all steady-state modes tested, particularly at the light loads and the maximum torque conditions. Particulate rates generally increase from light load to heavy load conditions for most engines, but the Cummins VTB-903 results were just the opposite, especially in the maladjusted configuration. As given in Table 36, the 13-mode composite particulate increased 78 percent, from 0.32 to 0.57 g/kW-hr.

Injector maladjustment was probably the major contributor to increasing particulate at light loads; and the reduction of maximum boost pressure, in combination with injector maladjustment, likely caused the increases in particulate emissions at the high load conditions. During transient testing, the maladjustment caused the composite brake specific particulate to increase by a factor of 2.1 (112 percent). The transient test cycle is generally regarded as a lightly-loaded test cycle, with an overall load factor about 20 percent. From Figure 17, the maladjustment caused significant increases in particulate emissions over the light load conditions which are predominant during the transient cycle.

Composite sulfate rates from modal and transient testing were given in Table 36. Modal sulfate emissions on a brake and fuel specific basis are shown in Figure 19. Both 13-mode composite and transient composite sulfate data indicate that sulfate production decreased by approximately 16 percent in the maladjusted configuration. This was not expected, since maladjustment produced more particulate and higher BSFC. Examining Table B-19, the maladjusted cold-start transient produced more sulfate than the baseline cold-start. However, the maladjusted hot-start transient produced less sulfate than the baseline hot-start. After applying the cold-to-hot weighting factors, the transient test results followed the 13-mode results, showing a 13 percent reduction of sulfate emission with maladjustment.

The average modal percent of fuel sulfur converted to sulfate decreased from 1.7 to 1.5 percent with maladjustment. Similar results were obtained for the transient test with the composite percent of fuel sulfur converted to sulfate decreasing from 1.7 to 1.4 percent with maladjustment.

Additional samples of total particulate from both engine configurations were analyzed for elemental composition, by oxidation for C and H content, and by x-ray fluorescence for other elements. Table 37 gives the percentage by weight of C, h, and N contained in total particulate samples collected on 47 mm Type A glass fiber filter media. The H/C mole ratios were also computed, and are presented in Table 37. Generally, the particulate from the maladjusted configuration contained slightly more carbon and substantially higher hydrogen except at the maximum torque and maximum power conditions.

For the VTB-903, maladjustment increased the 7-mode composite H/C mole ratio of the particulate from 0.84 to 0.95, and increased the transient FTP composite H/C mole ratio from 0.95 to 1.05. These changes imply that the nature of the particulate became more "oily" with maladjustment. For the most part, nitrogen content was lower with maladjustment during modal operation, but transient operation resulted in slightly higher nitrogen content.

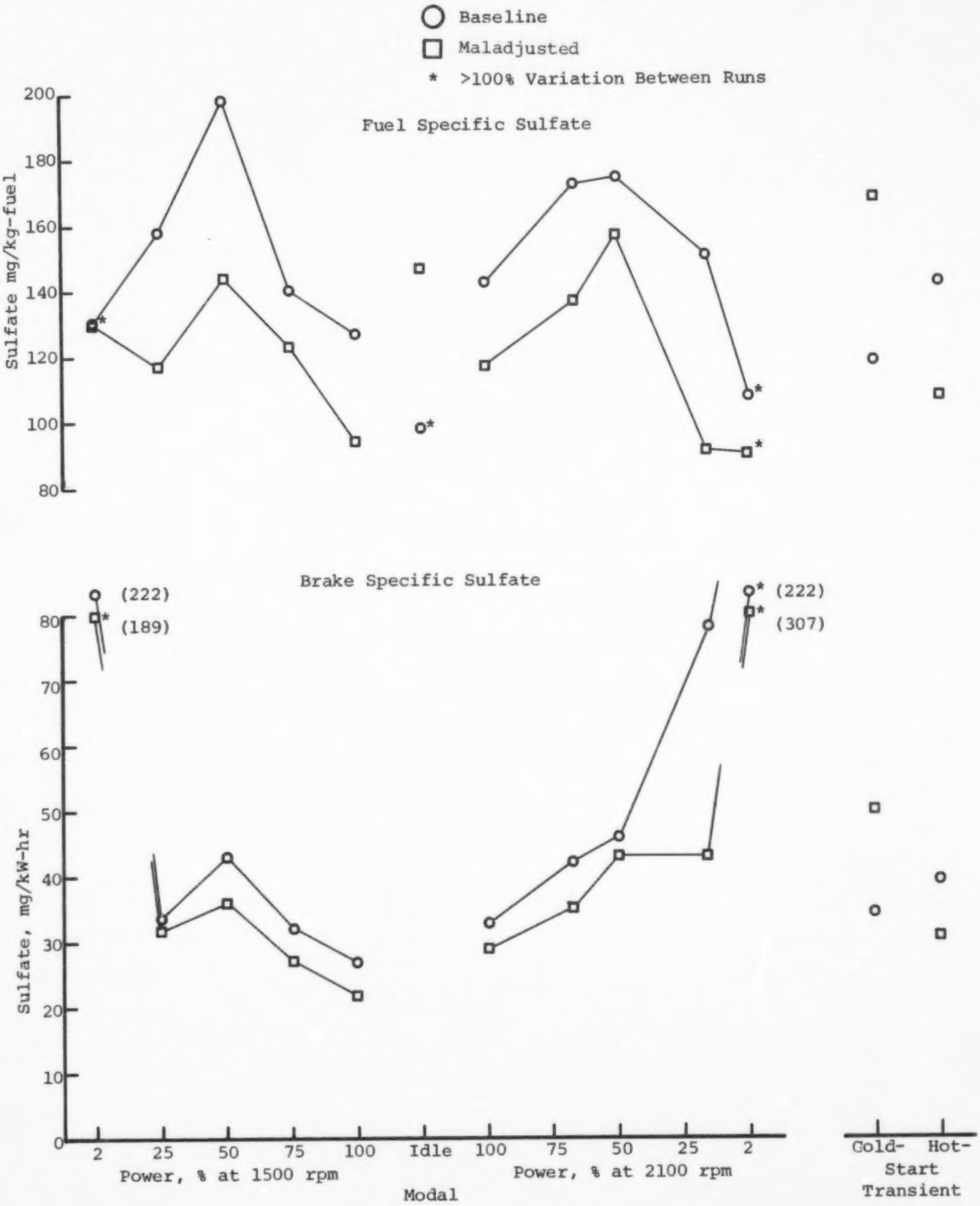

Figure 19. Brake and fuel specific sulfate from Cummins VTB-903 in baseline and maladjusted configurations

TABLE 37. CARBON, HYDROGEN, AND NITROGEN CONTENT OF FILTER PARTICULATE FROM THE CUMMINS VTB-903 (PERCENT BY WEIGHT BASED ON TYPE A GLASS FIBER FILTER SAMPLES)

Engine rpm/ % Load	Configuration		C	H	N	H/C Ratio
1500/2	Baseline		73.37	7.28	0.91	1.18
	Maladjusted		77.59	8.19	0.72	1.26
1500/50	Baseline		57.53	3.39	0.84	0.68
	Maladjusted		66.74	5.53	1.19	0.99
1500/100	Baseline		56.89	2.08	1.58	0.44
	Maladjusted		68.77	1.67	0.67	0.29
Idle	Baseline		73.62	5.96	2.16	0.96
	Maladjusted		70.77	6.26	1.37	1.05
2100/100	Baseline		46.79	3.71	1.97	0.94
	Maladjusted		75.46	3.11	0.89	0.64
2100/50	Baseline		50.36	3.16	1.22	0.75
	Maladjusted		69.10	6.05	1.29	1.04
2100/2	Baseline		74.37	5.89	0.97	0.94
	Maladjusted		76.37	8.04	0.75	1.25
Cold Transient	Baseline	1	68.37	5.64	0.95	0.98
		2	70.33	5.19	0.98	0.88
		Avg.	69.35	5.42	0.97	0.93
	Maladjusted	1	73.01	7.68	0.92	1.25
		2	74.09	7.36	1.10	1.18
		Avg.	73.55	7.52	1.01	1.22
Hot Transient	Baseline	1	71.14	5.91	1.01	0.99
		2	62.55	4.71	0.96	0.90
		Avg.	66.85	5.31	0.99	0.95
	Maladjusted	1	73.47	6.35	1.22	1.03
		2	73.60	6.22	1.27	1.01
		Avg.	73.54	6.29	1.25	1.02

Results from elemental analysis of particulate collected on Fluoropore filter media for both baseline and maladjusted configurations are given in Table 38. The elements, S, Mg, Cl, K, and P were most common. Sulfur was consistently lower in the maladjusted configuration, whereas phosphorus was slightly higher. No significant changes were noted for Mg, Cl, or K content due to the maladjustment.

A significant portion of the total particulate is generally made up of condensed fuel- and oil-like species. Large 20 x 20 inch particulate-laden filters were extracted to obtain samples of these organics, using methylene chloride as a solvent. Solute from this extraction process is referred to as the soluble organic fraction (SOF). SOF emissions over 7 modes of steady-state operation in both test configurations are summarized in Table 39. Results from transient test operation are summarized in Table 40.

TABLE 39. MODAL SOF EMISSIONS FOR THE CUMMINS VTB-903 IN BASELINE AND MALADJUSTED CONFIGURATIONS

Operating Condition	Engine Configuration	Total Particulate Rate, g/hr	Soluble Organic Fraction, %	SOF Emission Rate, g/hr
1500/2	Baseline	27.56	92.10	25.38
	Maladjusted	65.65	87.56	57.48
1500/50	Baseline	22.87	18.91	4.32
	Maladjusted	30.75	35.34	10.87
1500/100	Baseline	27.92	8.09	2.26
	Maladjusted	48.05	10.46	5.03
Idle	Baseline	6.01	76.78	4.61
	Maladjusted	15.60	51.46	8.03
2100.100	Baseline	28.85	21.58	6.23
	Maladjusted	45.15	23.72	10.71
2100/50	Baseline	26.32	19.01	5.00
	Maladjusted	51.78	66.63	34.50
2100/2	Baseline	39.57	57.72	22.84
	Maladjusted	64.53	81.50	52.59
7-Mode Composite	Baseline	23.94	38.51	9.22
	Maladjusted	43.13	55.56	23.96

		Baseline	Maladjusted	Unit
7-Mode Composite:	Brake Specific SOF	0.13	0.34	g SOF/kW-hr
	Fuel Specific SOF	0.50	1.23	g SOF/kg fuel

TABLE 38. METALS ANALYSIS OF FILTER COLLECTED PARTICULATE FROM THE CUMMINS VTB-903 (PERCENT BY WEIGHT BASED ON FLUOROPORE FILTER SAMPLES)

Condition Speed/ % Load	Configuration	Na	S	Cd	Mg	Cl	Cu	Al	K	Zn	Sb	Si	Ca	Fe	Ba	P
Inter/2	Baseline		0.99		0.01^a	0.01^a										0.03
	Maladjusted		0.62		0.01^a	0.01^a			0.01^a				0.02^a			0.03
Inter/25	Baseline		3.34		0.01^a	0.01^a							0.02^a			0.03
	Maladjusted	0.04^a	2.51		0.02^a	0.01^a							0.03^a			0.05
Inter/50	Baseline		5.45		0.01^a	0.01^a			0.01^a				0.08			0.07
	Maladjusted	0.04^a	4.75		0.02^a	0.01^a			0.09^a				0.05^a			0.09
Inter/75	Baseline		7.95		0.02^a	0.02^a							0.20			0.20
	Maladjusted		3.31			0.02^a			0.02^a				0.05			0.10
Inter/100	Baseline		6.40		0.01^a	0.07			0.03				0.20			0.16
	Maladjusted		3.15		0.01^a	0.02			0.01^a				0.05^a			0.06
Idle	Baseline		1.87		0.01^a								0.12			0.11
	Maladjusted		1.14			0.03^a			0.27^a				0.11^a			0.14
High/100	Baseline	0.10^a	7.20		0.01^a	0.01^a							0.05^a	0.14	0.03^a	0.07
	Maladjusted		5.20			0.04			0.13^a				0.08			0.06
High/75	Baseline		6.52		0.01^a	0.01^a							0.10		0.03^a	0.09
	Maladjusted		2.85		0.01^a	0.01^a			0.01^a				0.03^a			0.08
High/50	Baseline		5.66			0.01							0.01			0.05
	Maladjusted		3.08			0.01^a			0.01^a				0.03^a			0.06
High/25	Baseline		3.40		0.03^a	0.02							0.03^a			0.03
	Maladjusted		2.17		0.04	0.01^a			0.02^a				0.09			0.12
High/2	Baseline	0.10	0.99		0.01^a						0.02^a		0.06		0.02^a	0.05
	Maladjusted		0.87		0.07^a	0.05			0.02^a			0.04^a	0.06			0.06
Condition	Configuration															
Cold Transient	Baseline 1		2.33	0.01^a	0.01	0.07	0.13^a	0.01^a	0.01^a	0.09^a			0.04^a	0.10^a		0.03
	Baseline 2	0.12	3.25			0.03						0.31		0.26^a		0.04
	Maladjusted 1		1.12			0.01^a					0.02^a		0.07			0.09
	Maladjusted 2	0.07^a	1.89		0.01^a	0.03^a			0.02^a				0.18			0.14
Hot Transient	Baseline 1	0.06^a	3.05		0.02	0.01^a		0.02^a	0.01^a			0.02^a	0.04^a			0.04
	Baseline 2		2.53		0.01^a	0.02^a			0.01^a				0.04^a			0.03
	Maladjusted 1		1.81		0.01^a	0.01^a			0.02^a				0.06^a			0.10
	Maladjusted 2		2.12			0.02^a			0.02^a		0.03^a		0.06^a			0.13

[a] These values are very close to the limit of detectability and are subject to a relatively large error in the calculated value shown above.

TABLE 40. TRANSIENT SOF EMISSIONS FROM THE CUMMINS VTB-903 IN BASELINE AND MALADJUSTED CONFIGURATIONS

Transient Test	Engine Configuration	Particulate[a] Emissions g/kW-hr	Soluble Organic Fraction, %	SOF Emission Rate, g SOF/kW-hr
Cold	Baseline	0.65[a]	59.76	0.39
Start	Maladjusted	1.46[b]	82.59	1.21
Hot	Baseline	0.49[a]	49.24	0.24
Start	Maladjusted	1.01[b]	75.54	0.76
Transient	Baseline	0.51[a]	50.98	0.26
Composite	Maladjusted	1.08[b]	76.32	0.83

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[a] Based on average of 3 runs
[b] Based on average of 2 runs

For the VTB-903 in baseline configuration, the soluble portion of the total particulate ranged from a high of 92 percent (at 2 percent/load intermediate speed) to a low of 8 percent at the maximum torque condition. In the maladjusted configuration, the soluble portion ranged from 87 to 10 percent. However, the total particulate emission rate increased such that the actual mass of soluble material emitted more than doubled during most steady-state operating conditions for the maladjusted configurations. The 7-mode composite brake specific emission of SOF increased from 0.13 to 0.34 g SOF/kW-hr. Over the transient FTP, brake specific SOF emission levels increased from 0.26 to 0.83 g/kW-hr with maladjustment. Most of the increase in solubles was attributed to light-load operation.

Weighted portions of SOF were combined to form a composite 7-mode SOF sample and form a transient composite SOF sample. Composite transient sample weighting dictates that the ratio of cold to hot sample by 1:6. Normally this weighting is done by combining the extract of a single 20 x 20 cold-start sample with the extract from six 20 x 20 hot-start samples. Since only a limited number of filters were available for characterization, only one cold-start and three hot-start samples were used for extraction. In order to maintain the cold:hot weighting ratio, 50 percent of the extract from a cold-start filter was added to 100 percent of the extract from the hot-start filters. A 7-mode weighted composite extract was formed by incorporating the respective 7-mode weighting factors, in conjunction with the particulate rate and the percent of extractables from each of the 7 modes. The individual extracts were brought to a unit volume, and prescribed portions of the diluted extracts were combined to form a common 7-mode composite extract. Table 41 illustrates the methodology used to obtain 7-mode composite samples for the baseline and malfunction configurations. Portions of these composite samples of SOF were distributed for analysis of C, H, N, and S, boiling point distribution and Ames bioassay.

TABLE 41. COMPUTATION FOR MIXING 7-MODE COMPOSITE EXTRACT FOR CHARACTERIZATION

Engine Condition	Weight. Factor	Part. Rate, g/hr[a]	Extract Fraction[b]	Π (W.F.xP.R.xE.F.)	Extract Fraction Comp.	Extract On Hand, mg	Combined Extract, mg	Combined Unit Vol., %
				Baseline				
1500/2	0.12	27.56	0.9210	3.046	0.3303	651.5	216.5	33.2
1500/50	0.16	22.87	0.1891	0.692	0.0705	68.5	49.2	71.7
1500/100	0.12	27.92	0.0809	0.271	0.0294	29.6	19.3	65.1
Idle	0.20	6.01	0.7678	0.923	0.1011	239.9	66.3	27.6
2100/100	0.12	28.85	0.2158	0.747	0.0810	53.1	53.1	100.0
2100/50	0.16	26.32	0.1901	0.801	0.0869	76.9	57.0	74.0
2100/2	0.12	39.57	0.5772	2.741	0.2973	450.0	194.8	43.3
				Σ9.221			655.4	
				Malfunction				
1500/2	0.12	65.65	0.8756	6.688	0.2186	1776.4	446.9	25.2
1500/50	0.16	30.75	0.3534	1.739	0.0732	163.9	116.2	70.9
1500/100	0.12	48.05	0.1046	0.603	0.0254	40.3	40.3	100.0
Idle	0.20	15.60	0.5146	1.606	0.0676	233.7	107.3	45.9
2100/100	0.12	45.15	0.2372	1.285	0.0541	93.6	85.8	91.8
2100/50	0.16	51.78	0.6663	5.520	0.2324	531.3	368.8	69.4
2100/2	0.12	64.53	0.8150	6.311	0.2657	1046.5	421.6	40.3
				Σ23.751			1586.9	

[a] Particulate emission rates based on 90 mm samples

[b] Soluble fractions based on extraction of 20 x 20 samples

Results from elemental analysis of the composite SOF samples are given in Table 42 along with computed H/C mole ratios. These results indicate little change in either carbon or hydrogen content of the SOF due to maladjustments. Similarly, little change in the H/C mole ratio of the SOF was noted. Nitrogen content of the SOF appeared to be about the same for both configurations of the VTB-903. Maladjustment did seem to increase the portion of sulfur found in the SOF, These data imply that, although the amount of SOF emitted increased substantially with the maladjustments, the makeup of the SOF was nearly the same as obtained over baseline operation.

TABLE 42. RESULTS OF ELEMENTAL ANALYSIS OF SOF FROM THE CUMMINS VTB-903

Configuration	SOF Sample	Run No.	Element in SOF, wt. %				H/C Ratio
			C	H	N[a]	S[a]	
Baseline	Transient Composite	1	78.20	10.76	0.27	0.66	1.64
		2	78.26	10.66			1.62
		Avg	78.23	10.71			1.63
	7-Mode Composite	1	77.46	10.35	0.17	0.77	1.59
		2	77.53	10.46			1.61
		Avg	77.50	10.40			1.60
Maladjusted	Transient Composite	1	78.18	10.45	0.25	0.78	1.59
		2	77.96	10.54			1.61
		Avg	78.07	10.50			1.60
	7-Mode Composite	1	78.01	10.56	0.26	0.96	1.61
		2	78.17	10.36			1.58
		Avg	78.09	10.46			1.60

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[a] Single determinations

The boiling point distributions of the composite SOF samples from both configurations of the VTB-903 are given in Table 43. Overall, little change in the boiling point distributions of the SOF was noted. The percentages of extractables recovered over the boiling point procedure were all near 60 percent at approximately 570°C.

Transient composite SOF samples were submitted to EG&G (under separate EPA Contract) for Ames bioassay, and the results are given in Table 44. For the VTB-903, the specific activities of the SOF generated in the maladjusted configuration were uniformly greater than in baseline configuration. SOF was also produced at a higher brake specific rate in the maladjusted configuration. The effect of these differences is that the brake specific response was much higher for the maladjusted configuration by factors of 4 to 13. Brake specific responses were also higher with metabolic activation in two of the three strains, indicating the presence of indirect-acting mutagens.

TABLE 43. BOILING POINT DISTRIBUTION OF SOLUBLE ORGANIC

Distillation Point	Boiling Point, °C			
	Transient		7-Mode	
	Baseline	Maladjusted	Baseline	Maladjusted
IBP	294	290	295	283
10% Point	365	349	352	327
20% Point	390	367	378	347
30% Point	413	385	405	364
40% Point	437	407	436	385
50% Point	472	448	497	418
60% Point	543	--	--	517
70% Point	--	--	--	--
80% Point	--	--	--	--
90% Point	--	--	--	--
EP Point	--	--	--	--
Recovery, %	64	59	54	62
at °C	581	574	568	560

TABLE 44. SUMMARY OF AMES RESPONSE TO TRANSIENT COMPOSITE SOF FROM BASELINE AND MALADJUSTED CONFIGURATION OF THE CUMMINS VTB-903

Test Strain	Metabolic Activ. Status	Test Configuration	Specific[a] Activity		Brake[b] Specific Response
			Test 1	Test 2	
TA98	No	Baseline	0.6	0.6	160
		Maladjusted	1.7	2.2	1600
	Yes	Baseline	0.8	0.8	210
		Maladjusted	2.8	3.8	2700
TA100	No	Baseline	2.8	2.8	730
		Maladjusted	5.0	3.1	3400
	Yes	Baseline	2.2	1.5	480
		Maladjusted	2.5	2.1	1900
TA1538	No	Baseline	0.6	0.3	120
		Maladjusted	1.0	1.0	830
	Yes	Baseline	0.9	0.9	230
		Maladjusted	3.3	1.5	2000

Note: Baseline SOF emission was 0.26 g SOF/kW-hr
Maladjusted SOF emission was 0.83 g SOF/kW-hr

[a] Specific activity has units of revertants per plate/μg SOF

[b] Average brake specific response has units of 10^3 revertants per plate/kW-hr

C. Emissions Characterization of a Detroit Diesel Allison Division 6V-71N Heavy-Duty Diesel Bus Engine in Baseline and Maladjusted Configurations

This section describes emissions characterization work conducted on the DDAD 6V-71N in both baseline and maladjusted configurations. Selection of the engine and maladjustments are discussed. Emission results are summarized in the text, and detailed information is given in Appendix C.

1. Test Engine

Original plans for this phase of the program called for comparative test work to be conducted on a 2-stroke DDAD 8V-71N coach engine. The baseline data were to be accumulated in conjunction with EPA Contract No. 68-03-2602 (in which baseline emissions over the transient test procedures were established).(14) The original plan for the maladjustment configuration was to provide noticeable increase in smoke. A 1979 model DDAD 8V-71N coach engine, with 125 durability hours, was submitted for testing under EPA Contract NO. 68-03-2603 as described in Table 45.

TABLE 45. INFORMATION FROM DDAD 8V-71N COACH ENGINE

Serial No.: 8VA 377265
Model Year: 1979
Idle Speed: 400 rpm
Intermediate Speed: 1260 rpm (1200 rpm peak torque)
Rated Speed: 2100 rpm
Intake Restriction: 25 in. H_2O at 2100 rpm
Exhaust Backpressure: 6.0 in. Hg at 2100 rpm
FTP for Smoke: "A" = 4.22%, "B" = 8.75%, "C" = 9.10%
13-Mode Emissions: HC = 0.73, CO = 7.47, NO_x = 6.99 grams/bhp-hr
Fuel Type: No. 1 Diesel

Air System at 2100 rpm	
Air box pressure (inches mercury) - min. at full load:	
At zero exhaust backpressure:	5.0
At maximum full-load exhaust backpressure:	9.6
Air inlet restriction (inches water) - full-load speed, max.:	
Dirty air cleaner (oil bath or dry type)	25.0
Clean air cleaner (with precleaner) (oil bath or dry type)	15.9
Clean air cleaner (less precleaner) (dry type)	11.5
Crankcase pressure (inches water) - max.:	3.0
Exhaust backpressure (inches mercury) - max.:	
Full load	6.0
No load	2.6

In July of 1979, the DDAD 8V-71N coach engine was installed in the transient test facility. Various refinements were made to the dynamometer control circuitry in order to accommodate the right-hand rotation (viewed from flywheel) of the coach engine. A detailed test plan had been worked out to provide for transient testing of the engine on No. 2 emissions fuel, followed by runs on No. 1 fuel, then on No. 1 fuel with intake restriction maladjusted. The actual settings to be used to simulate a malfunction were to be defined after baseline requirements under EPA Contract No. 68-03-2603 had been completed.

Several conversations were held with the Project Officer regarding the selection and application of maladjustments to be run on the 8V-71N engine. Originally, an injector malfunction was considered, but concern over destroying the emissions history developed for this particular engine caused a reassessment of the planned injector malfunction. After a rather limited and informal survey of individuals familiar with this type of engine, a consensus was reached that a practical maladjustment would be to effectively increase the air intake restriction. This would not only simulate a dirty air cleaner system, but would also represent problems associated with a clogged blower intake screen, faulty positioning of the emergency shutdown damper, loss of blower efficiency, coking of intake air cylinder ports, or abnormally high exhaust backpressure.

Since no quantitative measurements were readily available to decide on just how much air restriction constituted a realistic malfunction of any of these items, the following approach was recommended. The engine would be operated with "normal" exhaust and intake pressures while smoke and power were monitored. Percentage step changes in the quantity of intake air would be made, and changes in smoke and power would be noted.

After completing baseline test requirements (under Contract 68-03-2603) on No. 2 emissions fuel, the engine was fueled on No. 1 fuel and experiments to define the level of intake air maladjustment needed to produce a "smoky exhaust" were conducted. Thirteen-mode restrictions for this 8V-71N engine were 25 in. H_20 intake and 6 in. Hg backpressure, and transient restrictions were 17 in. H_20 intake and 2.5 in. Hg backpressure, at maximum power. Inlet and exhaust restrictions were set only at maximum power at rated speed, and restrictions were allowed to vary as the engine speed and load varied.

The smoke opacity was only 3.5 percent at rated power with No. 1 fuel and transient restrictions. When the air intake restriction was raised to 40 in. H_20 the smoke increased to 5.0 percent opacity. Power curve smoke data were taken with 13-mode restrictions. At rated power, the smoke was only 3.0 percent and at peak torque conditions (1260 rpm/100 percent load) smoke was 7.8 percent. These power curve conditions were repeated with 50 in. H_20 intake restriction set at rated power. Full power smoke at rated speed increased to 5.0 percent while peak torque conditions yielded 10.5 percent opacity. Due to the relatively minor change in smoke opacity with increased intake restriction and No. 1 fuel, the fuel was changed to No. 2 and the full power conditions were repeated. As the engine was lugged down from 2100 to 1260 rpm with 50 in. H_20 (at 2100 rpm), the smoke opacity increased from 7.5 to 15.5 percent. Power decreased with increased intake restriction as expected. These preliminary data, based on very brief periods of engine operation, indicated that the use of intake air restriction alone would not be adequate to produce the level of "malfunction" necessary to significantly influence emissions.

In another conversation with the Project Officer, it was agreed that air intake restriction, applied to a relatively new engine (125 hrs), would not be adequate to simulate a high-smoke-emitting in-use engine which would warrant public complaint. It was decided that the maladjustment would probably have to produce at least 20 percent smoke opacity when this "new" engine was operated at peak torque conditions with 1-D fuel. To accomplish this target, it was expected that the engine's timing would have to be retarded by about 4 degrees in conjunction with about 40 in. H_20 intake restriction.

DDAD was contacted by the Project Officer and by SwRI. Representatives of DDAD would not authorize any more than 2 degrees of timing retard and were concerned that the use of increased air intake restriction in combination with 2 degrees of timing retard might damage the engine. SwRI and the Project Officer felt that at least 4 degrees of timing retard, in addition to 40 in. H_20 intake restriction, would have to be permissible before this particular engine could be made to produce 20 percent smoke opacity. Since this engine was being tested under the baseline program under Contract No. 68-03-2603, we could not assess the engine's response to only 2 degrees of injection timing retard. Under these circumstances, the DDAD 8V-71N was disqualified for use under the program (Contract No. 68-03-2706). All preparations to collect samples were stopped.

Although the effort utilized in studying the smoke sensitivity of the DDAD 8V-71N seemed to be non-productive, it promoted further thought into the cause of "smoky exhaust" from 2-stroke coach engine. In May of 1981, Detroit Diesel Allison Division of GM supplied SwRI (through EPA) with a 1979 DDAD 6V-71N coach engine for use in this program. This engine was originally a 125 hr emissions test engine, and was equipped with type 7E60 injectors. Based on work with the 8V-71N, it was decided that the maladjusted configuration should include a set of well-used, somewhat substandard injectors which had been associated with "smoky exhaust" from an in-service bus.

Several bus properties were contacted by the Project Officer and by SwRI in an effort to obtain a set of "worn" injectors. Based on the difficulty encountered, it was decided that the injectors should be obtained locally. Management personnel of VIA Metropolitan Transit Co. of San Antonio were contacted, and expressed willingness to supply high-mileage injectors of types LSN-60, C60, or N-60 for the purpose of investigating a malfunction.

It was pointed out that VIA did not have any complete sets of faulty injectors and that injectors rarely failed or deteriorated noticeably in groups; but rather that they were replaced individually in case they became stuck or started leaking. In return for rebuilding injectors loaned to SwRI for the program, VIA offered to pull sets of LSN-60 injectors having relatively long accumulated service when buses came in for some other reason. They did so with two injector sets, and the pertinent service data on these injectors are given in Table 46, along with results of testing.

TABLE 46. SERVICE DATA AND CONDITION OF VIA INJECTORS (TYPE LSN-60) TESTED AT SwRI

Bus No.	Reason for Maintenance	Injector Location	Miles on Injector	Date Installed	Leakage	Opening Pressure	Spray Pattern
799	Main bearing web failure	#I right	82,987	10/20/78	OK	OK	good
		#II right	82,987	10/20/78	OK	OK	good
		#III right	82,987	10/20/78	OK	OK	good
		#I left	82,987	10/20/78	OK	OK	good
		#II left	82,987	10/20/78	OK	OK	good
		#III left	82,987	10/20/78	OK	OK	good
832	#III left piston and liner broken	#I right	150,215	4/21/77	OK	OK	good
		#II right	150,215	4/21/77	OK	OK	good
		#III right	150,215	4/21/77	OK	OK	good
		#I left	150,215	4/21/77	bad[a]	OK	good
		#II left	13,003	8/05/80	OK	OK	good
		#III left	150,215	4/21/77	OK	OK	bad[b]

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[a] Internal leakage indicating defective plunger or barrel
[b] Tip missing, sprayed one jet

These data indicated no problems with the set from bus No. 799. Two of the injectors from bus No. 832 showed wear or damage. Injector #I left would probably not be noticed as a performance problem in the field unless the internal leakage increased to the point of reducing power output from that cylinder measurably. It was difficult to project the history of the injector from #III left; but probably either the tip was blown off due to explosion of water in the tip (which could have led to the cylinder damage), or the tip was knocked off when the piston and liner broke due to some other cause.

The outcome of the injector tests was that those from bus No. 799 did not constitute a malfunctioning set because they were "ok," while those from bus No. 832 (#III left in particular) did not meet the program's needs because the malfunction was too severe. These injectors were returned to VIA "as-received." Attention was given to obtaining a set of injectors from a bus which had come in for routine maintenance, but was considerably more "smoky" than normal at that time.

All efforts to find a set of "malfunctioning" injectors from an in-service bus, removed from service due to high levels of smoke, were unsuccessful. In telephone consultation with the Project Officer, it was agreed that the DDAD 6V-71N coach engine (with 7E60 injectors) would undergo emissions characterization in the baseline configuration.

The engine was installed in the transient test facility as shown in Figure 20. The dynamometer and its associated controls and signal circuits were reversed to accommodate the right-hand engine rotation (viewed from the flywheel). Timing was verified to be within 0.003 inch of the timing specification of 1.500 ± 0.005 inch. Preliminary checks included a full-power check which yielded 131 kW (176 hp) at 2100 rpm using 35.8 kg fuel/hr (78.9 lbs

Considering the difficulty involved in trying to find "malfunctioning" (but not failed) injectors, it was decided to use injectors that had accumulated approximately 50,000 miles of city bus service. We were able to obtain a set of 7E60 injectors from "VIA" transient company which had accumulated 48,817 miles, and had been installed in their bus No. 359 in May of 1980. The Project Officer approved these injectors for use in the maladjusted configuration.

It was decided that the maladjusted configuration should be representative of a field condition in which the bus would remain in operation due to adequate performance, but which might be viewed as a "smoky" bus. It was difficult to decide on what item would cause a realistic malfunction without representing a part failure. In conjunction with the Project Officer, it was decided that the maladjusted configuration would be made up of individual maladjustments to the engine, which collectively would simulate a worn engine. In addition to substituting these injectors for the baseline injectors, it was agreed that the maladjusted configuration might also include maladjustments of the rack, throttle delay, and timing, as well as intake air restriction.

It was decided that the maladjustments would be made in a stepwise manner; one item of maladjustment would be incorporated, then a hot-start transient test would be conducted without changing dynamometer control parameters from the baseline configuration. This procedure would simulate a driver demanding the same performance from a maladjusted/malfunctioning engine as from the baseline/stock engine. The hot-start transient emission test would quantify the relative influence each maladjustment contributed to the final maladjusted configuration. During the hot transient test, emissions of HC, CO, NO_x, particulate and visible smoke (in-line smokemeter) were measured.

The first increment of maladjustment was the substitution of 50,000 mile injectors obtained from an in-use bus. These injectors had accumulated soot deposits on the tips, but from outward appearance seemed to be in good condition with no obvious defects. The substitution was straightforward and the rack adjustments were made according to the service manual. Injector timing was maintained the same as for the baseline configuration. Emissions were measured over a single hot-start cycle. Results from this single transient test are presented in Table 47 along with the average hot-start emission results from the baseline configuration. The worn injectors caused the CO emissions to increase by 67 percent and the particulate to increase by 34 percent. NO_x decreased 10 percent and fuel consumption increased by 6 percent.

In addition to the worn injectors, the timing was retarded by 0.020 inch in order to simulate a worn cam drive train which occurs normally with high mileage.(22) This 0.020 inch increase in setting from the 1.500 ± 0.005 inch timing setting effectively retards the timing by approximately 2.8 degree of crank angle.(23) Following the timing adjustment, a single hot-start transient test was conducted. As shown in Table 47, the NO_x was reduced another 22 percent and the fuel consumption increased by 3.6 percent with the retard of timing. Both CO and particulate emissions increased by about 30 percent.

TABLE 47. HOT-START TRANSIENT EMISSIONS FROM DDAD 6V-71N IN VARIOUS STAGES OF MALADJUSTMENT FROM THE BASELINE CONFIGURATION

Test Configuration	Regulated Emissions, g/kW-hr, (g/hp-hr)				Cycle BSFC kg/kW-hr, (lb/hp-hr)	Cycle Work kW-hr (hp-hr)
	HC[d]	CO	NO_x[b]	Part.		
Baseline Hot Avg.	2.47 (1.84)	5.84 (4.36)	9.79[c,d] (7.30)	0.70 (0.52)	0.313 (0.515)	8.24 (11.05)
+50,000 Mile Injectors	--[a] --	9.73 (7.26)	8.78[b] (6.55)	0.94 (0.70)	0.331 (0.544)	8.21 (11.00)
+0.020 Inch Retard	--[a] --	12.76 (9.52)	6.81[b] (5.08)	1.34 (1.00)	0.343 (0.565)	8.09 (10.84)
+No Throttle Delay	--[a] --	13.85 (10.33)	6.77[b] (5.05)	1.45 (1.08)	0.339 (0.558)	8.24 (11.05)
+Increase Intake Rest.	3.35 (2.50)	15.38 (11.47)	6.89[c,d] (5.14)	1.45 (1.08)	0.342 (0.562)	8.22 (11.02)

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[a] Continuous HC instrument failed--bag HC was used to process data.

[b] These NO_x values based on measurement of sample bag concentration--Continuous NO_x instrument undergoing unscheduled maintenance.

[c] Baseline NO_x emission by continuous on-line measurement was 9.97 g/kW-hr. Cumulative maladjustment NO_x emission by continuous on-line measurement was 7.63 g/kW-hr.

[d] Presented on the basis of bag measurement for comparison purposes.

Along with the old injectors and the retard of timing, the throttle delay mechanism was then adjusted such that essentially no throttle delay existed. This allowed the engine rack to respond immediately to the throttle command. It appears from the results of the single hot-start test that the absence of throttle delay had comparatively little effect on hot-start transient emissions, although both CO and particulate were increased by about 8 percent and NO_x and BSFC were slightly reduced.

An increase in engine air intake restriction was added to simulate a dirty air cleaner or blower intake screen. The transient intake restriction was raised from 17 in. H_2O to 25 in. H_2O (measured at maximum power). The effect of the increased air intake restriction was minimal in regards to NO_x, particulate and fuel consumption, but it did appear to increase CO emission somewhat. Results from the hot-start transient with the additional intake air restriction were also representative of the cumulative effect of all of the maladjustments.

Comparing the emission results from the cumulative maladjustments to the average hot-start emissions from the baseline configuration indicated that substantial changes in emissions had taken place. The HC appeared to have increased by 32 percent, CO increased by a factor of 2.6, NO_x decreased by 30 percent, particulate increased by a factor of 2.1, and fuel consumption increased by 9 percent. Copies of the hot-start transient test results from maladjustment testing are given in Tables C-1 through C-4 of Appendix C.

In addition to the gaseous and particulate emission data, in-line smoke data were taken during each transient test in order to observe any change in smoke attributable to the maladjustments. On the basis of the FTP for smoke, several points were chosen to provide relative smoke information thought to be indicative of smoke from peak, acceleration, no-load, and intermediate load conditions. Results from these smoke measurements are given below:

	Hot-Start Transient Smoke Opacity, Percent			
Configuration	Peak	Acceleration	No Load	Intermediate
Baseline Avg.	5.5	3.7	0.6	0.8
+50K Injectors	15.5	8.7	0.3	2.1
+Retard Timing	25.9	15.6	0.5	4.7
+No Throttle Delay	31.9	13.0	0.4	5.1
+Increase Restr.	31.6	13.5	0.2	3.0

Overall engine operation changed very little relative to the changes in emissions. Observed power under the baseline and maladjusted configurations is given below with associated end-of-stack smoke opacities.

Baseline
Max. Power: 440 ft lb at 100 rpm = 175.9 hp   Smoke: 2.4%
Max. Torque: 550 ft lb at 1260 rpm = 132.0 hp   Smoke: 8.0%

Combined Maladjustment
Max. Power: 420 ft lb at 2100 rpm = 167.9 hp   Smoke: 9.8%
Max. Torque: 515 ft lb at 1260 rpm = 123.6 hp   Smoke: 23.5%

Even though the smoke and particulate emissions increased significantly, maximum power and maximum torque were only reduced by 5 and 6 percent, respectively. This would imply that the malfunctioning engine would probably not be taken out of service on the basis of power loss. The preliminary data from the various tests were reviewed with the Project Officer, who later approved the cumulative maladjusted engine for emissions characterization under the "maladjusted" configuration.

2. Emission Results from the DDAD 6V-71N

Composite gaseous emission levels of the DDAD 6V-71N on the 13-mode FTP are given in Table 48 for both baseline and maladjusted configurations. Copies of the computer printouts of the individual 13-mode tests are presented in Tables C-6 through C-9 of Appendix C and give modal information along with composite results. Thirteen-mode composite HC was 23 percent lower for the maladjusted configuration than for the baseline configuration. Examining the modal data, significant reductions in HC occurred in the maladjusted configuration during maximum power and maximum torque conditions. A 27 percent reduction in NO_x emissions, primarily due to the retard in timing, was accompanied by an overall 6 percent increase in BSFC. Thirteen-mode CO emissions increased by a factor of 1.8.

TABLE 48. SUMMARY OF 13-MODE GASEOUS EMISSIONS FROM THE DDAD 6V-71N COACH ENGINE

	13-Mode FTP			
	Emissions, g/kW-hr (g/hp-hr)			BSFC, kg/kW-hr, (lb/hp-hr)
Test Configuration	HC	CO	NO_x	
Baseline	2.37 (1.77)	9.92 (7.40)	9.60 (7.16)	0.297 (0.488)
Maladjusted	1.82 (1.36)	17.83 (13.30)	6.98 (5.20)	0.316 (0.520)

Several transient FTP's were run on both engine configurations. The average transient emission values from these tests are given in Table 49. Copies of the computer printouts from the individual tests are given in Appendix C. Notes concerning individual runs made in the baseline configuration are given in Table C-10. For the baseline configuration, Tables C-11 and C-12 give cold-start transient results, Tables C-13 through C-16 give hot-start transient results, and Tables C-17 and C-18 give bus cycle results. The average of the results given in these tables are those given in Table 49. Tables C-19 through C-21 give results from tests when the engine was returned to baseline configuration, after testing in the maladjusted configuration was completed.

Notes concerning individual runs made in the maladjusted configuration are given in Table C-22. For the maladjusted configuration, Tables C-23 and C-24 give cold-start transient results, Tables C-25 through C-29 give hot-start results, and Tables C-30 and C-31 give bus cycle results. The average of the results given in these tables are those given in Table 49.

Baseline data show a significant difference between the cold- and hot-start cycle of the transient test. The cold-start produced 6.77 kW-hr as compared to 8.24 kW-hr from the hot-start. This significant difference was attributed to the throttle delay mechanism which utilized engine oil as a working fluid. The higher viscosity of the cold engine oil causes slower throttle response on the cold-start than on the hot-start. All emissions, including particulate and BSFC, were higher for the cold-start cycle. The experimental bus cycle was also run and had slightly higher emissions than the baseline composite values, except for CO, which was lower. The baseline configuration did not pass the statistical requirements for any of the transient cycles run, and in addition the cycle work was about 23 percent below the command cycle work.

TABLE 49. SUMMARY OF AVERAGE TRANSIENT EMISSIONS FORM THE DDAD 6V-71N COACH ENGINE

Cycle Type	Regulated Emissions, g/kW-hr, (g/hp-hr) HC	CO	NO$_x$^{a}	Part.	Cycle BSFC kg/kW-hr, (lb/hp-hr)	Cycle Work kW/hr, (hp-hr)
Baseline Configuration						
Cold Start	2.49 (1.86)	6.03 (4.50)	11.69 (8.72)	0.86 (0.64)	0.372 (0.612)	6.77 (9.07)
Hot Start	2.47 (1.84)	5.84 (4.36)	9.97 (7.44)	0.70 (0.52)	0.313 (0.515)	8.24 (11.05)
Transient Composite	2.47 (1.84)	5.87 (4.38)	10.21 (7.62)	0.72 (0.54)	0.322 (0.529)	8.03 (10.77)
Bus Cycle	2.72 (2.03)	4.65 (3.47)	10.27 (7.66)	0.83 (0.62)	0.339 (0.557)	3.31 (4.44)
Maladjusted Configuration						
Cold Start	2.18 (1.63)	16.58 (15.17)	7.53 (5.57)	1.66 (1.46)	0.338 (0.579)	8.37 (11.44)
Hot Start	2.18 (1.63)	16.58 (12.37)	7.53 (5.62)	1.66 (1.24)	0.338 (0.556)	8.37 (11.22)
Transient Composite	2.18 (1.63)	17.12 (12.77)	7.52 (5.61)	1.70 (1.27)	0.340 (0.559)	8.39 (11.25)
Bus Cycle	2.48 (1.85)	20.72 (15.46)	7.98 (5.95)	1.97 (1.47)	0.345 (0.567)	3.80 (5.09)

[a] Continuous NO$_x$

Dynamometer control settings established during baseline operation were not adjusted to compensate for different engine operation in the maladjusted configuration. In the maladjusted configuration, there was relatively little difference between the cold-start and hot-start emissions or work. All of the transient tests, except for one hot-start, run in the maladjusted configuration passed the statistical criteria for transient testing.

During transient operation, the HC emissions in the maladjusted configuration tended to be nearly 10 percent lower than for the baseline. Changes in the CO emissions with the maladjustment were even more pronounced for transient testing than steady-state test work. The CO emissions from the maladjusted configuration on the bus cycle were 4.4 times those obtained for baseline. Transient cycle emissions of NO$_x$ from the maladjusted configuration were 24 percent lower than the level obtained for the baseline configuration. The relative changes in regulated gaseous emissions on both 13-mode and transient FTP's are illustrated in Figure 21. Changes in BSFC were not as pronounced for the bus cycle as for the 13-mode or transient FTP's. Substantial increases in total particulate were noted with maladjustment. Particulate emissions will be discussed in greater detail later in the text of this section.

Dilute exhaust samples were collected and analyzed for several low molecular weight hydrocarbons or "individual hydrocarbons" (IHC). Transient composites and 7-mode composites of the total of individual hydrocarbons are given in Table 50. Detailed results of the individual hydrocarbon species are given in Table C-32 for transient operation, and in Tables C-33 and C-34 for baseline and maladjusted modal operation. IHC were not determined over the bus cycle.

TABLE 50. SUMMARY OF COMPOSITE INDIVIDUAL HYDROCARBONS FROM THE DDAD 6V-71N

Test Configuration	Transient Composite mg/kW-hr	7-Mode Composite mg/kW-hr
Baseline	190	150
Maladjusted	200	104

Ethylene and propylene were the predominant individual hydrocarbons emitted during both transient and steady-state testing of the DDAD 6V-71N coach engine. During transient testing in both configurations of the DDAD 6V-71N, ethylene and propylene accounted for roughly 62 and 30 percent of the total individual hydrocarbons noted, respectively. Although there was not much difference in the composite total of individual hydrocarbons from the transient testing, the composite total of individual hydrocarbons over the 7 modes tested actually decreased with maladjustment. In testing the baseline configuration under steady-state conditions, levels of both ethylene and propylene were highest at the maximum power condition; but they were significantly lower in the maladjusted configuration. The maladjustment caused increased emissions of most species of individual hydrocarbons at the 2 percent load conditions.

Aldehydes were measured using the DNPH procedure. This procedure was adapted to dilute exhaust samples in order to characterize the aldehydes during the transient cycle. A summary of total aldehydes from transient and modal operation is given in Table 51, indicating slightly higher levels of aldehyde emissions with maladjustment. Detailed aldehyde results for transient testing are given in Table C-35, and in Tables C-36 and C-37 for steady-state modal operation.

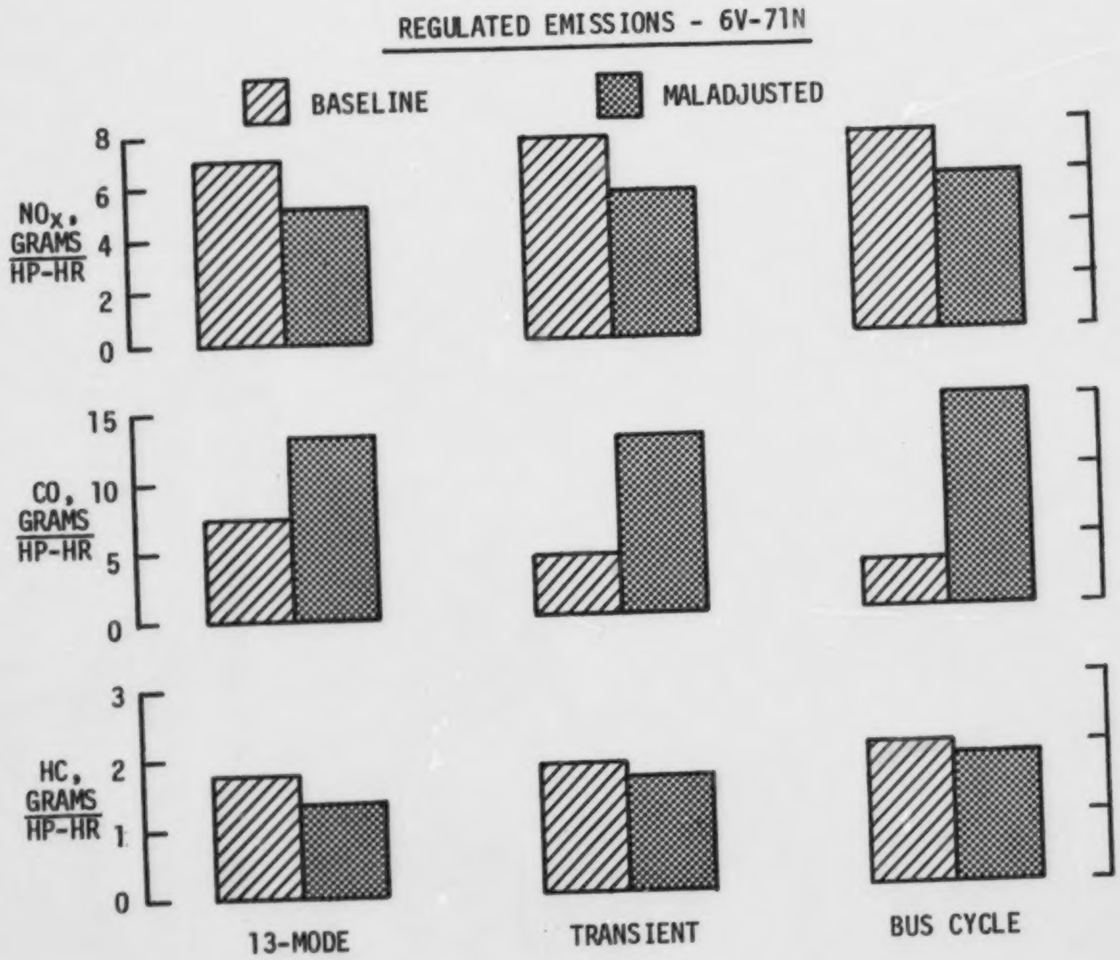

Figure 21. Regulated gaseous emissions from the DDAD 6V-71N in baseline and maladjusted configurations

TABLE 51. SUMMARY OF COMPOSITE ALDEHYDE EMISSIONS FROM THE DDAD 6V-71N

Test Configuration	Transient Composite mg/kW-hr	7-Mode Composite mg/kW-hr
Baseline	31	29
Maladjusted	44	36

Formaldehyde, isobutyraldehyde, and benzaldehyde were the only aldehydes detected over the transient cycle in either configuration. Formaldehyde was detected in both cold and hot cycle exhaust samples, with slightly higher levels detected in the maladjusted configuration. Essentially, no aldehydes were detected over the bus cycle in either configuration, although some isobutyraldehyde were also detected, but at relatively low levels.

Relative amounts of various phenols were determined by a wet chemistry procedure sampling dilute exhaust during the transient testing (bus cycle was not included) and raw exhaust during 5 modes of steady-state testing. Detailed transient phenol data are given in Table C-38, and steady-state results are given in Tables C-39 and C-40 for the baseline and maladjusted configurations, respectively. The most substituted phenol, 2-n-propylphenol, appeared for both cold- and hot-start cycles and was present for both configurations. The transient composite brake specific phenol level obtained in the baseline configuration increased from 58 to 340 mg/kW-hr with maladjustment. For both configurations, salicylaldehyde and 2-n-propylphenol were prevalent over the five modes of steady-state operation.

Total intensity of aroma (TIA) was determined for both configurations using the diesel odor analysis system (DOAS). Results from both transient (excluding the bus cycle) and steady-state testing are given in Tables C-41 and C-42, respectively. TIA was computed on the basis of both LCA and LCA. According to the developer, A.D. Little, the higher TIA value is most representative of odor intensity. For the DDAD 6V-71N, the 7-mode composite changed from 1.55 to 1.66, and the transient composite decreased from 1.80 to 1.69 for the baseline and maladjusted configurations, respectively. Based on the relatively small and mixed changes indicated, there was no significant change in exhaust odor due to the maladjustment of the DDAD 6V-71N.

One of the objectives of this work was to characterize the gaseous and particulate emissions associated with an engine producing "smoky" exhaust. Changes in smoke opacities from the baseline to maladjusted configurations were used in evaluating whether or not the maladjustment changes could simulate a smoky engine. Smoke opacities were determined using an end-of-stack EPA-PHS smokemeter.

Smoke was measured during the 13-mode testing as well as during the FTP for smoke and during selected steady-state points along the power curve. These smoke data are given in Table 52 and show significant increases in almost all power points tested. Figure 22 illustrates the change in smoke FTP levels with maladjustment. It is interesting, that all of the relatively large

TABLE 52. SMOKE OPACITY FROM THE DDAD 6V-71N COACH ENGINE

Federal Transient Smoke Cycle Opacity

	Smoke Opacity, %		
Configuration	"A"	"B"	"C"
Baseline	3.3	6.9	7.3
Maladjusted	26.8	19.5	38.6

Steady-State Smoke Opacity

13-Mode FTP			Smoke Opacity, %	
Mode	RPM	Power, %	Baseline	Maladjusted
1	Idle	--	0.2	0.1
2	1260	2	0.2	0.1
3	1260	25	0.3	0.1
4	1260	50	0.4	0.3
5	1260	75	0.9	2.8
6	1260	100	8.6	23.5
7	Idle	--	0.3	0.4
8	2100	100	2.3	9.5
9	2100	75	0.5	3.9
10	2100	50	0.3	1.7
11	2100	25	0.3	1.3
12	2100	2	0.3	1.1
13	Idle	--	0.2	0.1

Power Curve Smoke

		Smoke Opacity, %	
RPM	Power, %	Baseline	Maladjusted
2100	100	2.5	10.0
1900	100	2.2	11.3
1700	100	3.7	14.8
1500	100	4.1	16.3
1300	100	7.3	23.5
1260	100	7.5	--
1200	100	10.5	--

changes in smoke occurred during the high power conditions above 50 percent load. Relatively little change in smoke was noted for power points below the 50 percent load conditions.

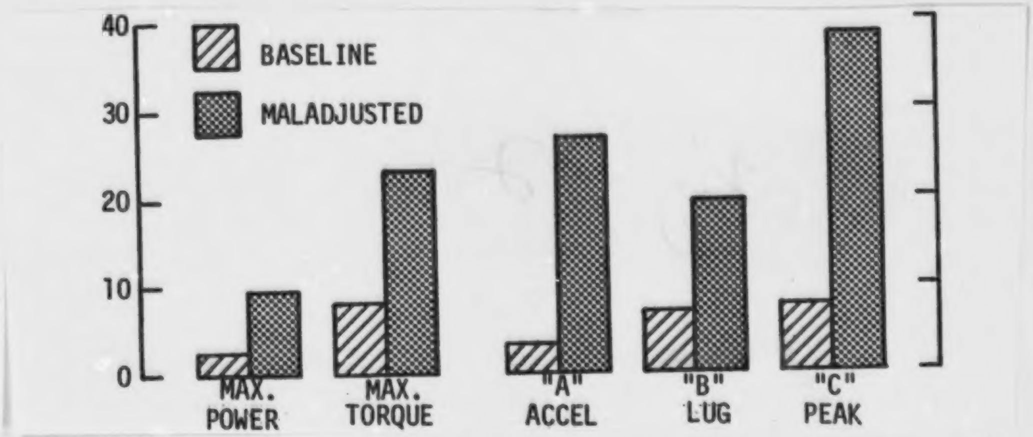

Figure 22. Smoke emissions from the DDAD 6V-71N

Since smoke and total particulate are related in that the relative level of smoke opacity indicates the relative level of particulate, the maladjustments were expected to cause significant changes in the total particulate emission levels as well as change the character of the particulate emitted. Total particulate was determined over both steady-state and transient operation, in both baseline and maladjusted configurations. Results from these determinations are summarized in Table 53. Particulate emissions for 7 modes of steady-state operation of the DDAD 6V-71N in both baseline and maladjusted configurations, are shown in Figure 23. Detailed particulate results over various transient test cycles are given along with the gaseous emissions in Tables C-11 through C-31. A summary of modal particulate emissions is given in Table C-43.

TABLE 53. SUMMARY OF TOTAL PARTICULATE EMISSIONS FROM THE DDAD 6V-71N

Test Cycle	Total Particulate Emissions, g/kW-hr	
	Baseline	Maladjusted
Cold-Start	0.86	1.66
Hot-Start	0.70	1.66
Transient Composite	0.72	1.70
Bus Cycle	0.83	1.97
7-Mode Composite	0.70	1.84

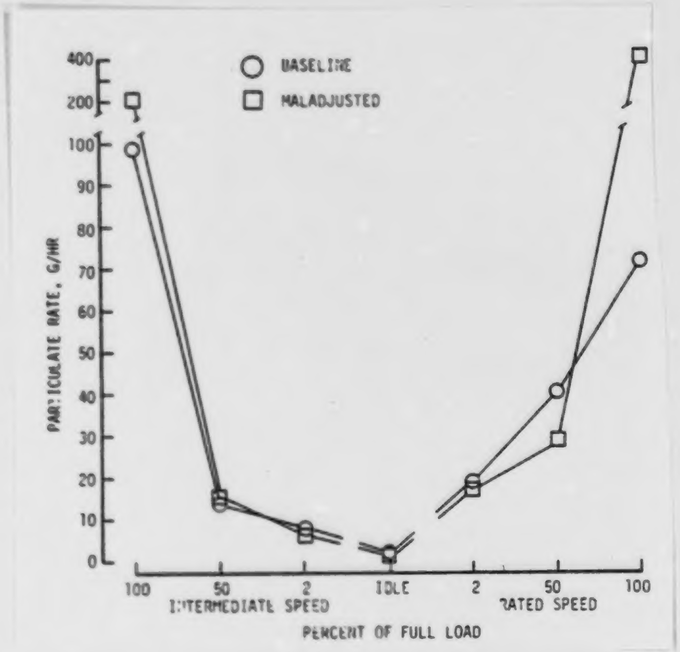

Figure 23. Modal particulate rates from the DDAD 6V-71N coach engine

Seven-mode composites of the particulate emissions in baseline and maladjusted configurations were 0.70 and 1.84 g/kW-hr, respectively. From Figure 23, this increase (by a factor of 2.6) was due to substantial increases in particulate emissions at the full load conditions during steady-state operation. Transient composite levels of particulate increased from 0.72 to 1.70 g/kW-hr with the maladjustments. This significant difference in transient particulate levels is primarily attributed to the absence of throttle delay (similar to a "puff limiter"), which would not appear to affect steady-state particulate emission determinations. Results from testing on the transient bus cycle were similar to results obtained on the transient FTP, namely that the brake specific particulate level increased by a factor of 2.4 with the maladjustments.

Sulfate emissions originating from the sulfur contained in the fuel, were determined using the barium chloranilate method on samples of total particulate collected on fluorocarbon membrane filter media. Sulfate results from transient and modal testing are summarized in Table 54. Results from modal testing are presented graphically in Figure 24. Detailed transient and modal sulfate results are given in Tables C-44 and C-45 of Appendix C, respectively.

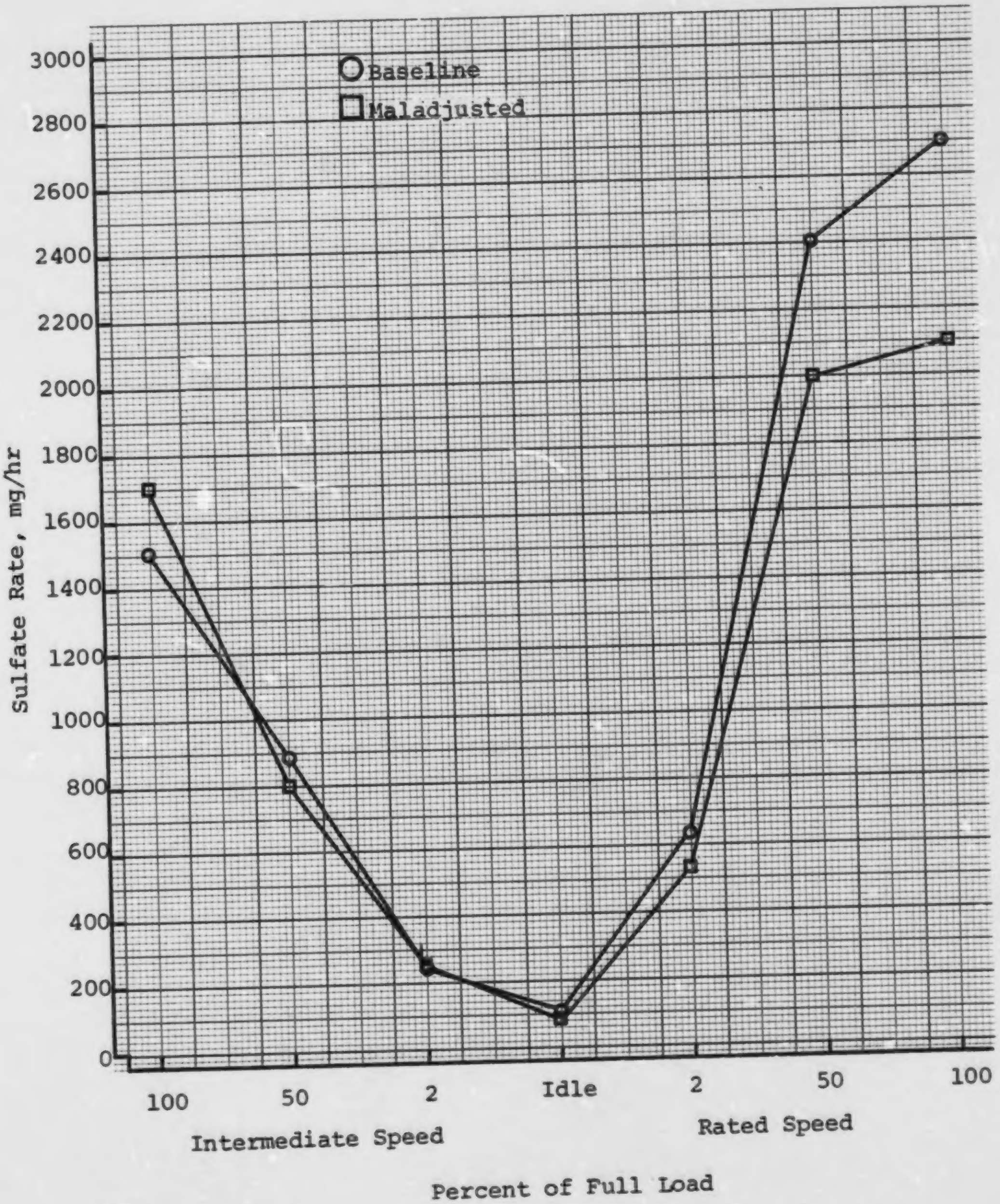

Figure 24. Modal sulfate rates from the DDAD 6V-71N coach engine

TABLE 54. SUMMARY OF SULFATE EMISSIONS FROM THE DDAD 6V-71N

Test Cycle	Sulfate Emissions, mg/kW-hr Baseline	Maladjusted
Cold-Start	28	22
Hot-Start	28	18
Transient Composite	28	19
7-Mode Composite	25	23

Sulfate emissions from the maladjusted configuration were nearly equivalent to or slightly less than baseline levels at most steady-state operating conditions. Composite sulfate results in Table 54 show that maladjustment reduced the 7-mode composite level by 7 percent, and the transient FTP composite level by 32 percent. It is likely that the maladjustment caused deterioration in the combustion process, resulting in less oxidation of the sulfur contained in the fuel. For the DDAD 6V-71N under transient test conditions, the reduction in sulfate emissions may have been particularly noticeable due to fuel-rich accelerations caused by the absence of throttle delay in the maladjusted configuration.

In addition, a lower percentage of fuel sulfur was converted to sulfate with maladjustment (data given in Tables C-44 and C-45). The most notable changes in sulfate with maladjustment were a 22 percent reduction of sulfate at maximum power and a 17 percent reduction at 50 percent load/rated speed conditions.

Elemental analysis of the total particulate required two particulate samples. The carbon and hydrogen content of the total particulate were determined from particulate samples collected on glass fiber filter media by oxidation techniques. Sulfur and metal content were determined from particulate samples collected on Teflon membrane filter media (Fluoropore) using X-ray fluorescence techniques. Table 55 gives the results from elemental analysis of steady-state and transient particulate samples. The results are presented as percent of each element in the total particulate sample analyzed. Of all the elements determined, carbon and hydrogen made up the bulk of the total particulate, followed by sulfur, then calcium, phosphorus, chlorine, aluminum, and zinc. The "total," given in Table 55 does not include C, H, and N, but does include sulfur and the other elements found. Computed H/C ratios are given in Table 55 along with computed transient and modal composite H/C ratio.

Examining the modal data, carbon was lowest and hydrogen highest (high H/C mole ratio) during light loads and idle where unburned fuel-like constituents are often found. Maladjustment appears to have increased the carbon content of the total particulate relative to the hydrogen content, resulting in a lower H/C mole ratio. Maladjustment of the DDAD 6V-71N

TABLE 55. SUMMARY OF ELEMENTAL ANALYSIS OF TOTAL PARTICULATE FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE

Condition rpm/load, %	Test Configuration	Element, Percent by Weight of Total Particulate C	H	H/C	"S"	Mg	Al	Si	P	Cl	Ca	Cr	Mn	Fe	Zn	Sn	Sb	Pb	"Total"[c]
1260/2	Baseline	59.8	9.0	1.79	1.90	b	0.01	0.03	0.16	0.11	0.28	b	a	b	0.14	a	a	b	2.8
	Maladjusted	56.7	9.7	2.04	1.79	b	0.01	a	0.14	0.06	0.24	b	b	b	a	b	b	b	2.7
1260/50	Baseline	69.2	10.4	1.79	2.94	b	0.03	0.16	0.12	0.04	0.33	a	a	a	0.15	a	a	b	4.3
	Maladjusted	64.1	8.0	1.49	2.16	b	0.01	0.03	0.11	0.08	0.23	a	0.22	a	a	a	a	a	3.7
1260/100	Baseline	84.9	2.7	0.33	0.40	b	0.06	0.07	a	0.06	0.12	b	a	a	a	a	b	b	1.0
	Maladjusted	87.2	1.3	0.13	0.18	0.01	0.01	0.03	a	0.05	0.04	b	b	a	a	b	b	b	0.4
Idle	Baseline	68.9	9.9	1.71	3.45	b	0.03	0.08	a	a	0.36	a	0.84	b	b	a	a	b	5.7
	Maladjusted	53.2	7.6	1.70	3.56	b	0.06	a	a	0.18	a	b	0.68	b	b	a	b	b	4.9
2100/100	Baseline	67.2	3.5	0.62	1.58	b	0.52	0.56	0.12	0.03	0.36	b	a	0.26	0.19	a	a	b	5.0
	Maladjusted	88.4	1.6	0.22	0.47	b	0.03	0.04	0.04	0.05	0.11	a	0.06	a	a	a	a	b	1.0
2100/50	Baseline	60.4	7.5	1.48	2.45	b	0.68	0.75	0.11	a	0.26	b	b	0.31	0.13	b	b	b	4.9
	Maladjusted	70.4	5.8	0.98	2.52	b	0.03	0.05	0.14	0.07	0.25	b	0.08	0.04	0.11	0.02	a	0.53	4.0
2100/2	Baseline	65.3	9.6	1.75	1.15	a	0.03	0.13	0.09	0.05	0.51	a	a	0.31	0.11	a	a	b	2.9
	Maladjusted	58.7	6.9	1.40	1.61	b	0.03	0.18	0.10	0.06	0.26	a	a	a	a	a	a	a	3.1
7-Mode Composite	Baseline			1.40															
	Maladjusted			1.19															

Transient Cycle	Test Configuration	C	H	H/C	"S"	N[d,e]	Al	Si	P	Cl	Ca	Cr	Mn	Fe	Zn	Sn	Sb	Pb	"Total"[c]
Cold Start Transient	Baseline	77.0	10.1	1.56	1.80	0.77	0.03	0.04	0.12	a	0.24	b	a	a	a	a	b	b	2.6
	Maladjusted	69.7	2.6	0.44	0.60	0.50	0.01	0.02	0.04	0.03	0.12	a	a	a	0.10	a	a	b	1.6
Hot Start Transient	Baseline	67.7	8.4	1.48	1.44	0.70	0.03	0.05	0.11	a	0.25	a	a	b	a	a	a	b	2.9
	Maladjusted	77.3	3.4	0.52	0.72	f	0.01	0.04	0.06	0.04	0.18	a	0.13	a	a	a	a	b	1.5
Transient Composite	Baseline			1.49															
	Maladjusted			0.51															

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[a] Element detected but was below the level of quantitiation

[b] Element was not detected

[c] "Total" represents the percent of total mass detected by X-ray and does not include Carbon, Hydrogen, Nitrogen or Oxygen

[d] Mg was not detected in the transient particulate samples

[e] Additional analysis for Nitrogen was conducted on transient particulate samples

[f] Value from analysis was 4.27 percent. This value seems unreasonably high and probably erroneous

decreased the 7-mode composite H/C mole ratio from 1.40 to 1.19, and decreased the transient FTP composite from 1.49 to 0.51, implying that the particulate was "drier" (more carbonaceous) due to maladjustment. Elemental sulfur content of the total particulate was generally lower for the maladjusted configurations. Little or no change in lubricating oil-related elements (P, Ca, Zn) was noted. "Totals" of elements from modal operation in the maladjusted configuration were lower than for the baseline configuration except at the 2100 rpm, 2 percent load condition. "Total" percent of elements detected by x-ray decreased with the maladjustment on transient testing also. Nitrogen, analyzed for transient operation only, also decreased with maladjustment.

In addition to elemental and sulfate analyses of the total particulate, the soluble organic fraction (SOF) of the total particulate was determined in both transient and steady-state particulate samples from both configurations. Table 56 gives transient cycle and composite SOF emissions in both configurations. Individual modal SOF information is given in Table C-46 of Appendix C. For the maladjusted DDAD 6V-71N, the percent of SOF noted for most steady-state modes remained about the same as for the baseline configuration, except for full load conditions at both intermediate and rated speeds. At these two conditions, the soluble percentages were substantially reduced with maladjustment. When these soluble percentages are combined with the corresponding total particulate emissions, the 7-mode composites for both baseline and maladjusted configurations were the same at 0.20 g SOF/kW-hr. Over the lightly-loaded transient FTP, maladjustment caused the composite brake specific SOF level to decrease from 0.40 to 0.29 g SOF/kW-hr (28 percent). On the bus cycle, maladjustment decreased the level from 0.54 to 0.35 g SOF/kW-hr (35 percent). Observations of changes in the H/C mole ratio of the total particulate generally complement the changes observed for SOF due to maladjustments.

TABLE 56. SUMMARY OF CYCLE AND COMPOSITE SOLUBLE ORGANIC FRACTION FROM THE DDAD 6V-71N COACH ENGINE

Test Cycle Composite	Cycle Composite Soluble Organic Fraction			
	Baseline		Maladjustment	
	% SOF	g SOF/kW-hr	% SOF	g SOF/kW-hr
7-Mode Composite	28.9	0.20	10.7	0.20
Cold-Start Cycle	56.8	0.49	13.0	0.26
Hot-Start Cycle	56.1	0.39	18.0	0.30
Transient Composite	56.2	0.40	17.1	0.29
Bus Cycle	64.6	0.54	17.9	0.35

Weighted portions of SOF extracts from transient FTP operation were combined to form a composite transient sample. Similarly weighted portions of SOF obtained from seven individual modes were combined to form a composite 7-mode sample. Composite SOF samples from both configurations were analyzed for C, H, N, and S, and the results are given in Table 57 along with computed H/C mole ratios. Only slight variation in these elements occurred with maladjustment. For the DDAD 6V-71N, the H/C ratio of both the 7-mode composite SOF and the transient composite SOF were 1.86 in the baseline configuration and 1.68 in the maladjusted configuration (recall that the H/C ratio of diesel fuels and lubricating oils is approximately 1.8). No significant change in nitrogen or sulfur content of the SOF occurred for either engine when maladjusted.

TABLE 57. ELEMENTAL COMPOSITION OF SOLUBLE ORGANIC FRACTION FROM THE DDAD 6V-71N COACH ENGINE

Test Configuration	Test Composite	Element, Percent of SOF				
		C[a]	H[a]	H/C	N[b]	S[c]
Baseline	Transient	84.68	13.15	1.85	0.24	0.49
Baseline	7-Mode	79.40	12.46	1.87	0.21	0.56
Maladjusted	Transient	80.48	11.32	1.67	0.35	0.57
Maladjusted	7-Mode	82.79	11.77	1.69	0.31	0.57

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[a] Analysis conducted by Galbraith Laboratories
[b] Nitrogen content determined by CL
[c] Sulfur content determined by x-ray

The boiling point distributions of the composite SOF samples are tabulated in Table 58. Results from the baseline transient sample stand out as having a relatively high initial boiling point and relatively low percentage recovery compared to the maladjusted transient SOF sample. Samples of composite SOF from the DDAD 6V-71N were submitted for analysis of BaP content, but no concentrations above the detection limit of 0.0002 μg/mg SOF were noted for either configuration.

TABLE 58. BOILING POINT DISTRIBUTION OF SOLUBLE ORGANIC FRACTION FROM DDAD 6V-71N COACH ENGINE

Distillation Point	Boiling Temperature of Distillation Point, °C			
	Transient		7-Mode	
	Baseline	Maladjusted	Baseline	Maladjusted
IBP	307	230	244	257
10% point	391	368	380	371
20% point	412	398	407	405
30% point	432	418	427	429
40% point	452	437	447	453
50% point	474	458	469	482
60% point	503	481	497	521
70% point	542	510	533	640
80% point	607	547	583	---
90% point	---	593	---	---
EP point	---	---	---	---
Recovery, % at 640°C	84	98	88	70

Composite SOF samples from transient and steady-state operation were submitted for Ames bioassay. The samples were tested in replicate over 5 strains (TA98, TA100, TA1535, TA1537, and TA1538), with and without metabolic activation. Results from Ames testing are given in Table 59, and include the slope of dose response, which represents the statistically-determined slope of the function representing revertants per plate versus micrograms SOF dosage. This result is termed "specific activity," and is an indication of the level of mutagenic potential of the extract. Results are also given in terms of brake specific response, which represents the specific activity multiplied by the SOF brake specific emission rate. The units for the brake specific response are then

$$\frac{\text{thousand revertants/plate}}{\text{kW-hr}}$$

The "thousand revertants per plate" per "kW-hr" is useful for comparison purposes, but has no practical meaning. The specific activities from replicate tests are given under the headings, "Test 1" and "Test 2." The average of these specific activities was used in conjunction with the brake specific emission of SOF to calculate the brake specific response.

Of the five tester strains used in the Ames analysis of the transient composite SOF samples, the highest levels of specific activity from all the SOF samples were noted for strains TA98 and TA100. On these two strains, the specific activities (along with brake specific response) without metabolic activation were greater than with activation. On strain TA1538, the opposite was noted. For the transient composite SOF sample, the brake specific responses with maladjustment were near those obtained on baseline. However, on strain TA100 without activation, a noticeably greater brake specific

TABLE 59. SUMMARY OF AMES RESPONSE SOF FROM THE DDAD 6V-71N

Test Configuration	Total Particulate Rate g/kW-hr	Soluble Organic Fraction g/kW-hr	Metabolic Activation Status	Strain TA98			Strain TA100			Strain 1535			Strain TA1537			Strain TA1538		
				Specific Activity[a]		Brake Specific Response[b]	Specific Activity[a]		Brake Specific Response[b]	Specific Activity[a]		Brake Specific Response[b]	Specific Activity[a]		Brake Specific Response[b]	Specific Activity[a]		Brake Specific Response[b]
				Test 1	Test 2		Test 1	Test 2		Test 1	Test 2		Test 1	Test 2		Test 1	Test 2	
Transient Baseline Composite[c]	0.72	0.40	Yes No	0.2 0.3	0.5 0.5	140 160	0.5 0.6	0.5 2.5	200 620	0.0 0.0	0.0 0.0	0 0	0.1 0.1	0.1 0.0	40 20	0.3 0.1	0.5 0.1	160 40
Transient Maladjusted Composite[d]	1.70	0.29	Yes No	0.5 0.5	0.3 0.5	120 150	0.6 4.0	0.9 2.9	220 1000	0.0 0.0	0.1 0.0	15 0	0.4 0.1	0.0 0.0	58 15	0.6 0.1	0.3 0.1	130 29
7-Mode Baseline Composite[e]	0.70	0.20	Yes No	1.2 0.4	0.5 0.2	170 60	0.4 1.8	0.5 1.4	90 320	0.0 0.0	0.1 0.1	10 10	0.0 0.0	0.1 0.0	10 0	0.7 0.2	0.5 0.1	120 30
7-Mode Maladjusted Composite[f]	1.84	0.20	Yes No	0.5 0.3	0.6 0.7	110 100	0.5 1.6	0.7 3.1	120 470	0.1 0.0	0.1 0.0	20 0	0.0 0.0	0.0 0.0	0 0	0.4 0.1	0.8 0.3	120 40

[a] Specific activity results from statistical analysis - given as "model predicted slope," "mean," represents revertants/μg SOF dose, samples run in replicate with one to two weeks between runs.

[b] Brake specific response has units of 10^3 revertants/plate/kW-hr, based on average slope of Test 1 and Test 2

[c] Sample CABS-81-410

[d] Sample CABS-81-430

[e] Sample CABS-81-400

[f] Sample CABS-81-420

response was obtained with maladjustment. For the 7-mode composite SOF sample, the differences in brake specific responses from baseline and maladjusted configurations were minimal. There appears to be a slight trend to higher brake specific response with maladjustment.

VI. EMISSIONS CHARACTERIZATION OF THREE DIESEL-POWERED CITY TRANSIT BUSES

The most recent and final phase of the work conducted under this contract involved emissions characterization of three in-service buses over various chassis dynamometer driving cycles. The three buses and the fuels used in this work are described in Section A. Section B describes the analytical and test procedures along with the various chassis dynamometer test cycles used. Emission results are summarized in Section C, and detailed emissions information is given in Appendix D.

A. Test Buses and Fuels

Three buses used in this program were obtained from an in-service fleet operated by Houston Metropolitan Transit Authority. The total fleet of 760 contained 288 GMC RTS II Type 4 buses, powered by DDAD 6V-92TA engines and covering model years 1981 through 1984. All the 6V-92TA engines were fitted with 7G65 series injectors. Houston Metro is currently converting their operation from No. 1 to No. 2 diesel fuel. Buses of model year 1984 were operated on No. 2 fuel, and earlier models were operated on No. 1 fuel. The three buses used in this work were randomly selected by Houston Metro with the following qualifications: one bus on No. 2 and two buses on No. 1 fuel, powered by the 2-stroke DDAD 6V-92TA, no less than 30,000 miles of service accumulation, no major engine maintenance performed. The three buses chosen for emissions characterization were No. 2162, No. 2126, and No. 1934, and they are described in Table 60 along with fuel and oil consumption figures from recent maintenance records. It should be noted that bus 2126 had better oil control than either bus 2162 or bus 1934. Properties of the two fuels used for emissions test work are given in Table 61. The test fuel was supplied through a fuel metering system in place of the on-board fuel supply.

TABLE 60. DESCRIPTION OF TEST VEHICLES IN HOUSTON METROPOLITAN TRANSIT AUTHORITY

Bus No.	2162	2126	1934
Bus Model	GMC RTS II 04	GMC RTS II 04	GMC RTS II 04
VIN	1G0YT82J8DV821917	1G0YT82J0DV821426	1G07T82J1CV820266
Engine No.	6VF104388	6VF100561	6VF088423
Engine Model	"Silver" 6V-92TA	"Silver" 6V-92TA	"Silver" 6V-92TA
Injectors	7G65	7G65	7G65
Fuel Type	No. 2	No. 1	No. 1
Rated Power, hp @ rpm	253 @ 2100	216 @ 2100	216 @ 2100
Start Service	September 1983	April 1983	September 1982
Service Accum. mi.[a]	55,066	99.856	138,781
Fuel Cons., mpg[b]	3.7	3.6	3.7
Oil Cons., mpqt.[b]	502	750	464
Major Engine Repair	None	None	None
GVWR, lbs	36,900	36,900	36,900
GVW, Empty, lbs	26,000	26,000	26,000
Capacity, Passengers	53	53	53

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[a] Prior to test

[b] Based on data taken over 1-2 months prior to testing

TABLE 61. PROPERTIES OF THE TWO DIESEL TEST FUELS

Fuel Description Fuel Code	No. 2 EM-597-F	No. 1 EM-400-F
Properties		
Density, g/mℓ	0.849	0.812
Gravity, °API	35.2	42.9
Cetane Index, (D-976)	46.2[a]	49.0
Viscosity, cS (D-445)	2.52	1.69
Flash Point, °C	72	70
Sulfur, wt. % (D-1266)	0.35	0.17
Gum, mg/100 m	--	4.6
Carbon, wt. %	86.12	86.37
Hydrogen, wt. %	12.92	13.54
Nitrogen, wt. %	0.08	0.0006
FIA:		
Aromatics, %	32.10	10.5
Olefins, %	1.33	1.5
Saturates, %	66.57	88.0
Distillation (D-86)		
IBP, °C	190	190
10% Point, °C	221	203
20% Point, °C	232	207
30% Point, °C	243	209
40% Point, °C	253	212
50% Point, °C	263	214
60% Point, °C	273	217
70% Point, °C	284	221
80% Point, °C	297	227
90% Point, °C	314	238
95% Point, °C	331	258
EBP, °C	345	293
Recovery, %	--	99
Residue, %	--	1
Loss	--	0

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[a] Cetane Number D-613

B. Test Procedures

The test plan, given in Table 62, indicate the various emissions characterized over a variety of driving cycles and steady-state conditions. Details concerning chassis testing of the buses and descriptions of the various cycles used are given in this section. Analytical procedures used to determine the emissions listed in Table 62 are described.

TABLE 62. TEST PLAN FOR EMISSIONS CHARACTERIZATION OF THREE IN-SERVICE BUSES

	Emissions Characterized						
Test Cycle	HC,CO CO_2,NO_x	Aldehydes	IHC	Smoke	Part.	Sulfate	SOF
Truck Cycle-Cold	X	X	X	X	X	X	X
Truck Cycle-Hot	X	X	X	X	X	X	X
Bus Cycle-Filtered	X	X	X	X	X	X	X
Bus Cycle-Unfiltered	X			X	X		
Central Business District[a]	X			X	X		
Idle in Drive[c]	X	X		X	X		
12.5 mph (20 kph) S.S.[c]	X	X		X	X		
25 mph (40 kph) S.S.[c]	X	X		X	X		
Idle in Neutral[b]				X			
Snap Idle[b]				X			
Stall[b]				X			

---

[a] CBD cycle run on Buses 2126 and 1934
[b] Procedure used by Tri-Met Bus Fleet
[c] Steady-state held for 15 minutes

1. Chassis Dynamometer Testing

The chassis dynamometer testing in this program was based on the test procedure outlined in EPA's "Recommended Practice for Determining Exhaust Emissions from Heavy-Duty Vehicles Under Transient Conditions."(24) The procedure specifies a speed-time exercise to be followed similar to that used in chassis dynamometer testing of light-duty vehicles.

The buses were received from Houston Metro such that only one bus was out-of-service for testing at any time. Upon arrival, the rear wheel/tire assemblies were changed to eliminate the risk of damage to Metro's tires. Once the bus was positioned on the chassis dynamometer, the rear axle load on the dynamometer was reduced by blocking up the frame of the bus, as shown in Figure 25. Figure 26 shows the rear axle tires of the bus positioned on the front pair of dynamometer rolls, with fans directed to cool the tires. Figure 27 shows the front portion of the bus along with the driver's station for monitoring road load, speed, roll counts and drivers' aid. To the left of the bus is the single-dilution CVS used in conjunction with heavy-duty chassis test work. All the exhaust gases generated were transferred to the CVS by a 4-inch diameter exhaust tube fitted with an in-line smokemeter as shown in Figure 28. The single-dilution CVS shown in Figure 27, has a capacity from 1000 to 12,000 SCFM. The tunnel is 46 inches in diameter and 57 feet long. This single-dilution CVS has the capacity to obtain three 20 x 20 inch filter samples of particulate matter along with additional samples needed for analysis of the total particulate.

The chassis dynamometer used in this program was essentially a tandem-axle Clayton heavy-duty chassis dynamometer modified by the addition of eddy current power absorbers. Electronic programming of the system enables obtaining essentially any required speed-power curve. By utilizing an electrical signal from the vehicle braking system, electrical braking of the dynamometer rolls is also provided. Each of the absorption units in tandem has dual rolls that are 8.625 inches in diameter. Inertia simulation is provided by an appropriate combination of directly-connected inertia wheels. Maximum inertia simulations readily attainable are 49,000 pounds for single-drive-axle vehicles and 76,000 pounds for tandem-drive-axle vehicles. Using the programmable dynamometer, the procedure developed for road load simulation of a vehicle on the dynamometer involves establishing the speed-power curve, determining inertia simulation, and determining system friction.

The equation selected for calculation of the speed-power curve to be used for evaluations on the chassis dynamometer is as follows:

$$RLP = F \times 0.67(H - 0.75) W \times (V/50)^3 + 0.00125 \times LVW \times V/50$$

Where:

RLP = Road Load Power in horsepower
F = 1.00 for tractor-trailer and 0.85 for city bus
H = Average maximum height in feet
W = Average maximum width in feet
LVW = Loaded vehicle weight in pounds
V = Velocity in mph

The equation used for determination of dynamometer torque and load are as follows:

Dynamometer Torque = Hp 134.8/mph, foot-pounds
Dynamometer Load = Torque 12/(Load Arm in inches), pounds

In keeping with the general provision in the EPA recommended Procedure,(24) the equivalent inertia set in the dynamometer system for evaluation of a tractor-trailer is equal to 70 percent of the gross combined weight. For buses, the equivalent inertia is equal to the sum of the empty weight, plus half passenger load, plus the driver (at 150 pounds per person), plus the equivalent inertia weight of the nonrotating vehicle wheel assemblies. For the three GMC RTS-II Type 4 buses, and inertia weight of 30,000 pounds was used.

With the vehicle installed on the dynamometer and with the appropriate inertia wheels connected, the total system absorbed horsepower was determined using coastdowns. This was accomplished by obtaining repeatable 55 to 5 mph coastdown speed versus time data and then solving for the instantaneous decelerations. From the instantaneous decelerations, the power absorption of the vehicle-dynamometer system was determined as a function of vehicle speed. The speed-power curve for programming into the dynamometer controller was then determined by difference between the total power required on the road (based on previous documentation obtained under Contract 68-02-3722)(25) and the power absorbed by the vehicle-dynamometer system.(26) Total road load for each of the three buses was 78.3 hp at 50 mph. Of this total, 40.8 hp was due to air resistance, and the balance of 37.5 hp was attributed to rolling resistance.

The main cycle used for testing is referred to as the "heavy-duty chassis driving cycle." This transient truck cycle was outlined in an EPA document titled "Recommended Practice for Determining Exhaust Emissions from Heavy-Duty Vehicles Under Transient Conditions."(24) The resulting driving cycle, shown in Figure 29, was based on data accumulated from truck and bus operation (CAPE-21)(15) and was used in this program as a "Cold- or Hot-Start Transient" test. Of the 1060 second duration of the cycle, 326 seconds are idle, and some idle is conducted in neutral. The distance over the test is 5.57 miles. The maximum speed called for by the cycle is 58 mph.

Since bus operation varies significantly from truck operation, data accumulated from bus operation (CAPE-21) were used to develop a "heavy-duty chassis bus driving cycle."(27) The driving schedule shown in Figure 30 was used in this program as an "Unfiltered Bus Cycle." The term "unfiltered" is used to indicate that this driving cycle was used as-received from computer-generated interpretation of bus operating data (CAPE-21). Of the 1191 second duration of the cycle, 394 seconds are idle, all of which is with the transmission in drive. The distance over the test is 2.90 miles. The maximum speed called for by the cycle is 36 mph. The unfiltered bus cycle is difficult to follow due to the many sharp accelerations and decelerations it contains.

A "Filtered" version of this "Unfiltered Bus Cycle" was generated, and was thought to approach more realistic operation of a transit bus vehicle. Further discussion and graphic representations of both the "Filtered" and "Unfiltered Bus Cycles" are given in Attachment D-1 of Appendix D and in Reference 28. Based on the discussion presented in this attachment, the "Filtered Bus Cycle" was selected over the "Unfiltered Bus Cycle" for more detailed emissions characterization.

A transient coach operating profile duty cycle has been proposed and used for evaluation of bus fuel economy. The duty cycle includes four phases of bus operation; a Central Business District phase, an Idle phase, an Arterial phase, and a Commuter phase.(29) Emphasis was placed on the Central Business District (CBD) phase. Based on its acceptance by the industry for the purpose of fuel economy measurement, emissions were also determined over the CBD operation. For this work, the CBD cycle was composed of 14 repetitions of the basic cycle, which included idle, acceleration, cruise and deceleration modes. An example of this basic cycle is given in Figure 31, and it was repeated 14 times for a chassis driving cycle of 580 seconds and a distance of 2.0 miles (3.22 km).

Emissions were also measured at three steady-state conditions including idle, 12.5 mph (20 kph), and 25 mph (40 kph). These conditions were maintained for 15 minutes to allow time for acquisition of aldehyde and particulate samples. The idle condition was performed with the transmission in drive. All emissions test work was conducted with the air conditioning system off.

In order to obtain additional smoke emission data, three short tests for smoke were conducted. These short tests had been used by Tri-Met (in the greater Portland Metropolitan area) to access the smoke emissions of its 710-bus fleet.(30) In all of these tests, the opacity meter is placed at the exhaust

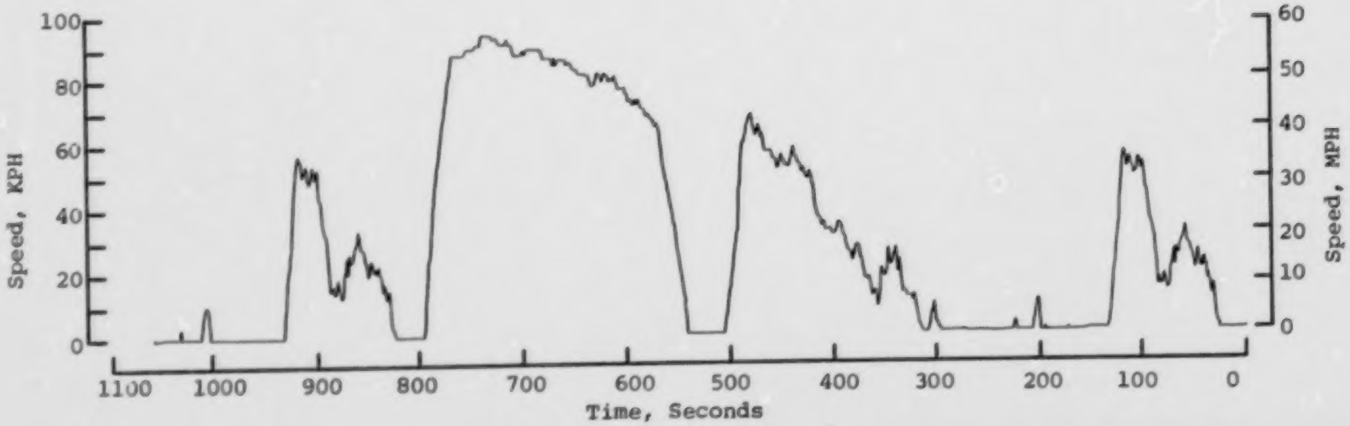

Figure 29. Heavy-duty chassis driving cycle (truck cycle)

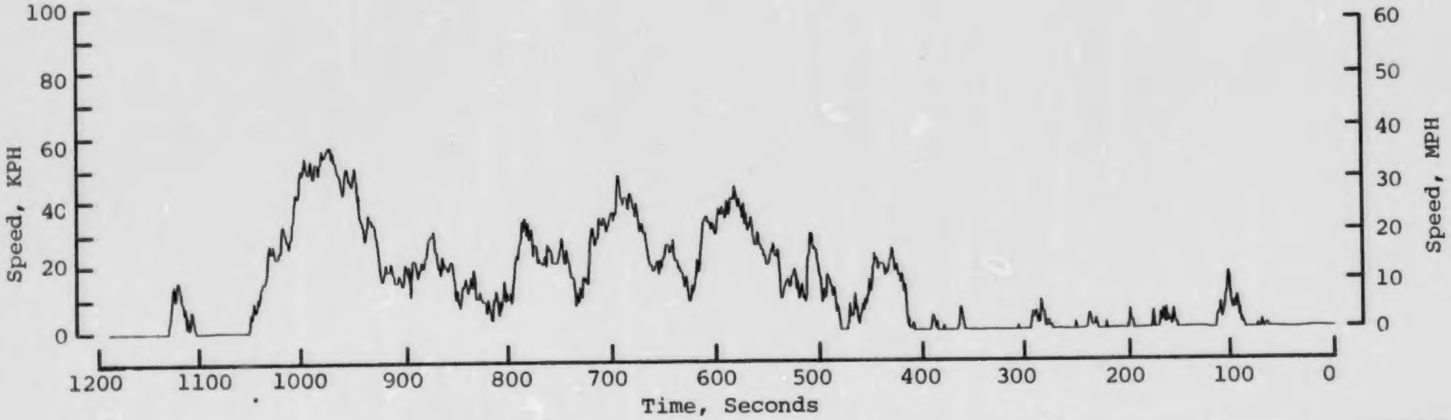

Figure 30. Heavy-duty chassis bus driving cycle (unfiltered bus cycle)

stack outlet. An "idle" test was conducted by measuring the opacity of the exhaust gas exiting at a curbed engine idle in neutral gear. In the "stall idle" test, the bus was placed in drive and the vehicle's brakes were applied. The throttle was then opened to full throttle, bringing the engine speed up against the internal governor's resistance to the transmission stall speed. Opacity measurements were made when the engine was at that maximum RPM. During the "snap idle" test, the vehicle was in neutral gear. The engine throttle was rapidly opened to bring the engine RPM up to governor maximum and then released. This was done three times in rapid succession. Peak opacity levels were recorded.

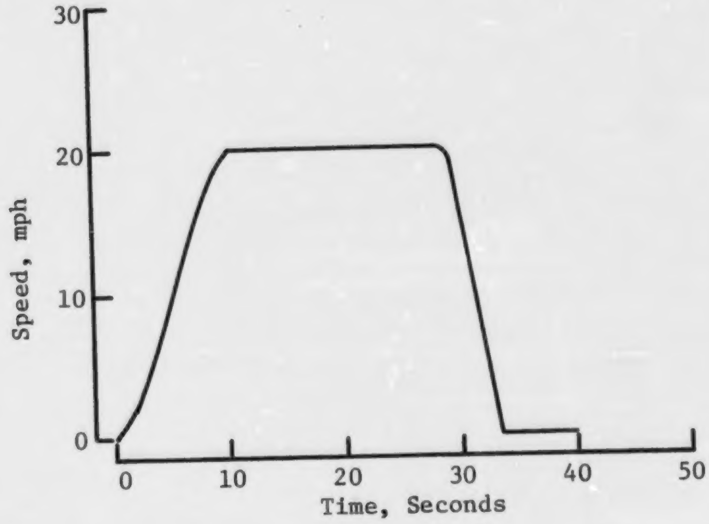

Figure 31. One segment of the CBD test cycle

2. Analytical Procedures

Regulated gaseous emissions of HC, CO, and NO_x were measured along with CO_2 according to the 1984 transient FTP.(2) The transient test procedure specifies that HC be determined from integration of continuous concentration monitoring of the CVS-diluted exhaust. The procedure provides the option of determining CO, CO_2, and NO_x from either dilute sample bags or from integration of continuous concentration monitoring. For HC emissions, CVS-diluted exhaust was taken from the main dilution tunnel using the prescribed heated probe and heated filter, and was transferred to the Beckman 402 HFID by heated stainless steel sample line. CO and CO_2 levels were determined from proportional dilute exhaust bag samples. Concentrations of both gases were determined by non-dispersive infrared (NDIR) instruments. NO_x emissions were determined from both integration of continuous concentration monitoring of the CVS-diluted exhaust and from bag samples, by use of a chemiluminescence instrument. NO_x correction factors for intake humidity were applied as specified in the 1984 transient FTP (amended November 14, 1983).(31)

Some selected individual hydrocarbons (IHC) were determined from dilute exhaust bag samples taken over the cold- and hot-start chassis truck cycle and over the filtered bus cycle. A portion of the exhaust sample collected in the Tedlar bag was injected into a four-column gas chromatograph using a single flame ionization detector and dual sampling valves. The times sequence selection valves allowed the baseline separation of air, methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene.(10)

Aldehydes and ketones were determined using the 2,4-dinitrophenylhydrazine (DNPH) method.(32) Dilute exhaust samples were taken from the CVS dilution tunnel during cold- and hot-start chassis truck cycles, filtered bus cycles, and the three steady-state conditions. A heated Teflon sample line and filter were maintained at 190°C (375°F). The procedure consists of bubbling filtered exhaust gases, dilute or raw, through glass impinger traps containing a solution of DNPH and HCl kept at 0°C. The sample apparatus used for collecting the aldehyde sample is shown on the left side of Figure 27. The aldehydes form their respective phenylhydrazone derivatives (precipitates). These derivatives are removed by filtration, and subsequently extracted with pentane and evaporated in a vacuum oven. The remaining dried extract, which contains the phenylhydrazone derivatives, is dissolved in a specific volume of methanol with anthracene internal standard. A portion of this dissolved extract is injected into a liquid chromatograph and analyzed using an ultraviolet detector to separate formaldehyde, acetaldehyde, acrolein, acetone, propionaldehyde, isobutyraldehyde, methylethylketone, crotonaldehyde, hexanaldehyde, and benzaldehyde.

Particulate emissions were determined from dilute exhaust samples utilizing various collection media and apparatus, depending on the analysis to be performed. Particulate has been defined as any material collected on a fluorocarbon-coated glass fiber filter at or below a temperature of 51.7°C (125°F), excluding condensed water. The 125°F temperature limit and the absence of condensed water dictates that the raw exhaust be diluted, irrespective of engine operating mode. The temperature limit generally required dilution ratios of approximately 12:1 (total mixture:raw exhaust).

Total particulate-rate samples were collected on 47 mm Pallflex T60A20 fluorocarbon-coated glass fiber filter media, by means of a single-dilution technique. Gravimetric weight gain, representing collected particulate, was determined to the nearest microgram after the filter temperature and humidity were stabilized. This weight gain, along with CVS flow parameters was used to calculate the total particulate mass emission from the bus under test.

Smoke and total particulate are related in that the relative level of smoke opacity indicates the relative level of particulate. The absence of smoke, however, does not indicate the absence of particulate. Smoke was determined by the end-of-stack EPA-PHS smokemeter modified to operate as an in-line smokemeter. Smoke opacity was monitored continuously during all bus operation.

Sulfate, originating from the combustion of sulfur-containing fuel, was collected as part of the particulate matter in the form of sulfate salts or sulfur acid aerosols. A 47 m Fluoropore (Millipore Corp.) fluorocarbon membrane filter with 0.5 micron pore size was used to collect the sample. This total particulate sample was ammoniated to "fix" the sulfate portion of the particulate. Using the barium chloranilate (BCA) analytical method, the sulfates were leached from the filter with an isopropyl alcohol-water solution (60% IPA). This extract was injected into a high pressure liquid chromatograph (HPLC) and pumped through a column to scrub out the cations and convert the sulfate to sulfuric acid. Passage through a reactor column of barium chloranilate crystals precipitates out barium sulfate and releases the highly UV-absorbing chloranilate ions. The amount of chloranilate ion released was determined by a sensitive liquid chromatograph UV detector at 310-313 nanometers. "Sulfate" should be understood to mean $SO_4^=$ as measured by the BCA method.(10)

Diesel particulate generally contains significant quantities of condensed fuel-like or oil-like hydrocarbon aerosols generated in incomplete combustion zones. In order to determine to what extent total particulate contains these various hydrocarbons, a large particulate-laden filter (20 x 20 inch) was washed with an organic solvent, methylene chloride, using 500 m soxhlet extraction apparatus. The washed filter was carefully dried and weighed to determine weight loss due to the extraction process. The dissolved portion of the "total particulate" carried off with the methylene chloride solvent has been referred to as the "soluble organic fraction" (SOF). The weight loss of the dried filter is essentially the amount of SOF which had been collected on the filter as part of the total particulate.(33)

C. Emission Results From Three GMC RTS II Type 4 Buses

Regulated emissions (HC, CO, and NO_x), along with particulate emissions, are summarized in Tables 63, 64, and 65 for buses numbered 2161, 2126, and 1934, respectively. The computer printouts for these tests are given in Tables D-1 through D-14 for bus 2162, Tables D-15 through D-30 for bus 2126, and Tables D-31 through D-39 for bus 1934. Emission results obtained from the various cycles run on a given bus are summarized in its corresponding table. The summary tables also include fuel consumption data.

Fuel consumption was computed by carbon balance, but was also determined from continuous monitoring by a fuel meter during the test run. Emissions are presented in the summary tables in terms of mass per unit distance and mass per unit mass of fuel. In computing fuel economy and emissions on a fuel specific basis, fuel usage from the carbon balance method was used. Results from the cold-and hot-start transient tests were weighted 1/7 and 6/7, respectively, and combined to determine composite chassis transient emissions levels.

For comparative purposes, emissions are summarized on a fuel specific basis in Table 66. Recall that bus 2162 was tested on No. 2 fuel, and that buses 2126 and 1934 were run on No. 1 fuel. Replicate runs were made on buses 2162 and 2126, and they indicated reasonably good repeatability. A single emissions test was run on bus 1934, except for a repeat hot-start transient test. The CBD cycle was not conducted on the first bus tested, bus 2162.

TABLE 63. SUMMARY OF TEST RESULTS FROM OPERATION OF BUS NO. 2162

Emissions Cycle	Test No.	Emissions, g/km, (g/kg fuel)					Fuel, kg		Test Distance, km	Fuel Economy ℓ/100 km (km/kg)
		HC	CO	NO_x		Total	Carbon	Cont.		
		Cont.	Bag	Bag	Cont.	Part.	Balance	Meas.		
Cold Start Transient	1	0.70 (1.55)	9.64 (21.29)	14.35 (31.69)	16.23 (35.84)	1.78 (3.93)	4.10	—	9.06	53.5 (2.208)
	2	0.75 (1.70)	7.88 (17.90)	14.62 (33.20)	15.17 (34.45)	1.99 (4.52)	3.94	—	8.95	52.0 (2.271)
	Avg	0.72 (1.63)	8.76 (19.59)	14.48 (32.44)	15.70 (35.14)	1.88 (4.22)	4.02	—	9.01	52.8 (2.240)
Hot Start Transient	1	0.75 (1.85)	7.46 (18.43)	13.73 (33.93)	14.57 (36.00)	1.62 (4.00)	3.69	3.82	9.13	47.8 (2.471)
	2	0.72 (1.85)	6.64 (17.04)	13.94 (35.78)	14.92 (38.30)	1.49 (3.82)	3.46	3.69	8.89	46.0 (2.567)
	Avg	0.74 (1.85)	7.05 (17.74)	13.84 (34.86)	14.75 (37.15)	1.56 (3.91)	3.58	3.76	9.01	46.90 (2.519)
Transient Composite		0.74 (1.82)	7.29 (18.00)	13.93 (34.51)	14.89 (36.86)	1.61 (3.95)	3.64	—	9.01	47.7 (2.479)
Bus Cycle Filtered	1	1.37 (3.14)	3.20 (7.32)	17.54 (40.13)	19.51 (44.64)	1.18 (2.70)	2.09	2.08	4.78	51.7 (2.288)
	2	1.55 (3.64)	3.07 (7.20)	17.80 (41.74)	18.41 (43.17)	0.89 (2.09)	2.03	2.07	4.76	50.4 (2.345)
	Avg	1.46 (3.39)	3.14 (7.26)	17.67 (40.94)	18.96 (43.90)	1.04 (2.39)	2.06	2.08	4.77	51.05 (2.317)
Bus Cycle Unfiltered	1	1.31 (2.44)	25.77 (48.06)	19.33 (36.05)	20.44 (38.12)	3.72 (6.94)	2.58	2.67	4.82	63.4 (1.865)
	2	1.28 (2.47)	21.95 (42.36)	18.73 (36.15)	19.60 (37.83)	3.16 (6.10)	2.47	2.53	4.76	61.3 (1.930)
	Avg	1.30 (2.46)	23.86 (45.21)	19.03 (36.10)	20.02 (37.98)	3.44 (6.52)	2.53	2.60	4.79	62.35 (1.898)

TABLE 63 (CONT'D). SUMMARY OF TEST RESULTS FROM OPERATION OF BUS NO. 2162

Emissions Cycle	Test No.	Emissions, g/km, (g/kg fuel)					Fuel, kg		Test Distance, km	Fuel Economy ℓ/100 km (km/kg)
		HC	CO	NO_x		Total				
		Cont.	Bag	Bag	Cont.	Part.	Carbon Balance	Cont. Meas.		
Idle In-Drive	1	-- (5.13)	-- (5.79)	-- (53.15)	-- (56.87)	(1.56)	0.90	0.83	--	-- (--)
	2	-- (5.35)	-- (6.04)	-- (53.83)	-- (57.04)	(1.49)	0.87	0.84	--	-- (--)
	Avg	-- (5.24)	-- (5.92)	-- (53.49)	-- (56.96)	(1.53)	0.89	0.83	--	-- (--)
20 kph Steady-State	1	1.64 (5.23)	1.54 (4.91)	12.91 (41.14)	14.31 (45.61)	0.50 (1.59)	1.61	1.62	5.13	37.1 (3.187)
	2	1.63 (5.29)	1.53 (4.96)	13.15 (42.66)	13.66 (44.31)	0.53 (1.72)	1.61	1.69	5.22	36.4 (3.244)
	Avg	1.64 (5.26)	1.54 (4.94)	13.03 (41.90)	13.99 (44.96)	0.52 (1.66)	1.61	1.66	5.18	36.75 (3.216)
40 kph Steady-State	1	0.95 (3.91)	0.93 (3.83)	9.00 (37.04)	9.62 (39.59)	0.46 (1.89)	2.49	2.58	10.25	28.7 (4.115)
	2	1.00 (4.14)	0.97 (4.02)	8.64 (35.80)	9.02 (37.38)	0.47 (1.95)	2.48	2.59	10.28	28.5 (4.144)
	Avg	0.98 (4.03)	0.95 (3.92)	8.82 (36.42)	9.32 (38.48)	0.46 (1.92)	2.48	2.58	10.27	28.60 (4.130)

TABLE 64. SUMMARY OF TEST RESULTS FROM OPERATION ON BUS NO. 2126

Emissions Cycle	Test No.	Emissions, g/km, (g/kg fuel)[a] HC Cont.	CO Bag	NO_x Bag	NO_x Cont.	Total Part.	Fuel, kg Carbon Balance	Fuel, kg Cont. Meas.	Test Distance, km	Fuel Economy ℓ/100 km (km/kg)
Cold Start Transient	1	0.88 (2.21)	4.14 (10.40)	10.96 (27.52)	11.57 (29.05)	1.20 (3.01)	3.47	3.81	8.72	49.0 (2.511)
	2	1.02 (2.51)	3.71 (9.14)	11.55 (28.46)	12.13 (29.89)	1.26 (3.11)	3.57	3.80	8.80	50.0 (2.464)
	Avg	0.95 (2.36)	3.92 (9.77)	11.26 (27.99)	11.85 (29.47)	1.23 (3.06)	3.52	3.80	8.76	49.50 (2.488)
Hot Start Transient	1	1.14 (3.16)	3.78 (10.47)	10.65 (29.49)	12.07 (33.42)	1.03 (2.85)	3.20	3.56	8.85	44.5 (2.769)
	2	1.20 (3.34)	3.30 (9.18)	11.14 (31.00)	11.74 (32.67)	0.90 (2.50)	3.20	3.50	8.90	44.3 (2.783)
	Avg	1.17 (3.25)	3.54 (9.83)	11.90 (30.24)	11.91 (33.04)	0.97 (2.68)	3.20	3.53	8.88	44.4 (2.776)
Transient Composite		1.13 (3.12)	3.59 (9.82)	11.81 (29.92)	11.90 (32.53)	1.01 (2.73)	3.25	3.57	8.86	45.1 (2.735)
Bus Cycle Filtered	1	1.99 (5.02)	3.46 (8.72)	14.87 (37.47)	15.60 (39.31)	0.91 (2.29)	1.81	2.00	4.56	49.0 (2.520)
	2	1.89 (4.75)	2.85 (7.17)	14.92 (37.52)	15.37 (38.66)	0.81 (2.04)	1.84	1.93	4.62	49.0 (2.515)
	Avg	1.94 (4.89)	3.16 (7.94)	14.90 (37.50)	15.48 (38.99)	0.86 (2.16)	1.82	1.96	4.59	49.0 (2.518)
Bus Cycle Unfiltered	1	2.00 (4.47)	6.81 (15.23)	15.50 (34.67)	16.16 (36.15)	1.44 (3.22)	2.06	2.31	4.61	55.1 (2.237)
	2	1.56 (3.46)	6.04 (13.40)	15.81 (35.07)	16.98 (37.66)	1.19 (2.64)	2.13	2.32	4.73	55.5 (2.218)
	Avg	1.78 (3.96)	6.43 (14.32)	16.66 (34.87)	16.57 (36.90)	1.32 (2.93)	2.10	2.32	4.67	55.30 (2.228)

TABLE 64 (CONT'D). SUMMARY OF TEST RESULTS FROM OPERATION ON BUS NO. 2126

Emissions Cycle	Test No.	Emissions, g/km, (g/kg fuel)[a] HC Cont.	CO Bag	NO_x Bag	NO_x Cont.	Total Part.	Fuel, kg Carbon Balance	Fuel, kg Cont. Meas.	Test Distance, km	Fuel Economy ℓ/100 km (km/kg)
Centrol Business District	1	1.73 (3.44)	10.49 (20.84)	16.67 (33.12)	18.11 (35.99)	1.74 (3.46)	1.63	1.80	3.23	62.0 (1.987)
	2	1.77 (3.38)	9.21 (17.58)	16.96 (32.38)	18.62 (35.55)	1.72 (3.28)	1.69	1.77	3.23	64.5 (1.909)
	Avg	1.75 (3.41)	9.85 (19.21)	16.82 (32.75)	18.36 (35.77)	1.73 (3.37)	1.66	1.78	3.23	63.25 (1.948)
Idle In-Drive	1	-- (8.20)	-- (7.21)	-- (51.7)	-- (53.6)	-- (1.42)	0.75	0.82	--	-- (--)
	2	-- (7.95)	-- (6.64)	-- (52.5)	-- (52.4)	-- (1.22)	0.75	0.82	--	-- (--)
	Avg	-- (8.08)	-- (6.93)	-- (52.10)	-- (53.00)	-- (1.32)	0.75	0.82		-- (--)
20 kph Steady-State	1	1.92 (6.92)	1.72 (6.20)	10.45 (37.66)	11.18 (40.29)	0.53 (1.91)	1.40	1.58	5.05	34.2 (3.604)
	2	2.11 (7.33)	1.89 (6.57)	10.65 (37.00)	11.40 (39.60)	0.45 (1.56)	1.46	1.56	5.06	35.4 (3.474)
	Avg	2.02 (7.12)	1.81 (6.38)	10.55 (37.33)	11.29 (39.94)	0.49 (1.20)	1.43	1.57	5.06	34.8 (3.539)
40 kph Steady-State	1	1.21 (5.65)	1.19 (5.56)	6.92 (32.32)	7.21 (33.68)	0.46 (2.15)	2.15	2.46	10.0	26.3 (4.671)
	2	1.16 (5.32)	1.20 (5.51)	7.04 (32.31)	7.43 (34.10)	0.41 (1.88)	2.19	2.42	10.0	26.8 (4.590)
	Avg	1.18 (5.48)	1.20 (5.54)	6.98 (32.32)	7.32 (33.89)	0.44 (2.02)	2.17	2.44	10.0	26.55 (4.631)

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[a] Fuel specific emissions computed using carbon balance fuel figure

TABLE 65. SUMMARY OF TEST RESULTS FROM OPERATION ON BUS NO. 1934

Emissions Tests		Emissions, g/km, (g/kg fuel)					Fuel, kg		Test Distance, km	Fuel Economy ℓ/100 km (km/kg)
		HC	CO	NO_x		Total				
Cycle	No.	Cont.	Bag	Bag	Cont.	Part.	Carbon Balance	Cont. Meas.		
Cold Start Transient	1	1.84 (4.32)	9.27 (21.34)	9.54 (22.37)	10.09 (23.66)	3.24 (7.60)	3.76	3.89	8.83	52.5 (2.345)
Hot Start Transient	1	1.63 (4.23)	8.03 (20.84)	9.47 (24.58)	9.71 (25.20)	2.32 (6.02)	3.42	3.58	8.88	47.5 (2.595)
	2	1.73 (4.47)	7.17 (18.53)	9.55 (24.69)	9.64 (24.92)	2.24 (5.79)	3.44	3.60	8.90	47.6 (2.585)
	Avg.	1.68 (4.35)	7.60 (19.68)	9.51 (24.64)	9.68 (25.06)	2.28 (5.90)	3.43	3.59	8.89	47.6 (2.590)
Transient Composite		1.70 (4.35)	7.84 (19.92)	9.51 (24.32)	9.74 (24.86)	2.42 (6.14)	3.48	3.63	8.88	48.3 (2.555)
Bus Cycle Filtered	1	3.14 (7.62)	6.20 (15.04)	12.90 (31.30)	12.97 (31.47)	2.13 (5.17)	1.89	1.99	4.59	50.8 (2.426)
Bus Cycle Unfiltered	1	2.89 (5.84)	15.95 (32.25)	13.23 (26.75)	13.61 (27.52)	3.91 (7.91)	2.33	2.44	4.71	60.9 (2.022)
Central Business District	1	2.52 (4.66)	17.78 (32.86)	13.99 (25.85)	14.48 (26.76)	3.92 (7.24)	1.78	1.74	3.30	66.6 (1.848)
Idle In-Drive	1	-- (12.36)	-- (9.38)	-- (45.46)	-- (47.59)	-- (2.47)	0.80	0.78	--	-- (--)
20 kph Steady-State	1	2.55 (9.20)	3.27 (11.80)	9.09 (32.80)	10.05 (36.26)	1.05 (3.79)	1.42	1.59	5.13	34.1 (3.608)
40 kph Steady-State	1	1.38 (6.23)	2.51 (11.33)	6.01 (27.14)	6.26 (28.26)	0.51 (2.30)	2.23	2.39	10.1	27.2 (4.515)

TABLE 66. SUMMARY OF FUEL SPECIFIC EMISSIONS FROM THREE GMC RTS II TYPE 4 BUSES POWERED BY DDAD 6V-92TA ENGINES

Cycle	Bus No.	Emissions, g/kg fuel					Fuel Economy	
		HC	CO	NO_x[b]	NO_x	Part	kg	km/kg
Cold Start Transient	2162	1.63	19.59	32.44	35.44	4.22	4.02	2.24
	2126	2.36	9.77	27.99	29.47	3.06	3.52	2.49
	1934	4.32	21.34	22.37	23.66	7.60	3.76	2.34
Hot Start Transient	2162	1.85	17.74	34.86	37.15	3.91	3.58	2.52
	2126	3.25	9.83	30.24	33.04	2.68	3.20	2.78
	1934	4.35	19.68	24.64	25.06	5.90	3.43	2.59
Composite Transient	2162	1.82	18.00	34.51	36.86	3.95	3.64	2.48
	2126	3.12	9.82	29.92	32.53	2.73	3.25	2.74
	1934	4.35	19.92	24.32	24.86	6.14	3.48	2.56
Bus Cycle Filtered	2162	3.39	7.26	40.94	43.90	2.39	2.06	2.32
	2126	4.89	7.94	37.50	38.99	2.16	1.82	2.52
	1934	7.62	15.04	31.30	31.47	5.17	1.89	2.43
Bus Cycle Unfiltered	2162	2.46	45.21	36.10	37.98	6.52	2.53	1.90
	2126	3.96	14.32	34.97	36.90	2.93	2.10	2.23
	1934	5.84	32.25	26.75	27.52	7.91	2.33	2.02
CBD	2162	--	--	--	--	--	--	--
	2126	3.41	19.21	32.75	35.77	3.37	1.66	1.95
	1934	4.66	32.86	25.85	26.76	7.26	1.78	1.85
Idle[a]	2162	5.24	5.92	53.49	56.96	1.53	0.89	--
	2126	8.08	6.93	52.10	53.00	1.32	0.75	--
	1934	12.36	9.38	45.46	47.59	2.47	0.80	--
20 kph[a]	2162	5.26	4.94	41.90	44.96	1.66	1.61	3.22
	2126	7.12	6.38	37.33	39.94	1.20	1.43	3.54
	1934	9.20	11.80	32.80	36.26	3.79	1.42	3.61
40 kph[a]	2162	4.03	3.92	36.42	38.48	1.92	2.48	4.13
	2126	5.48	5.54	32.32	33.89	2.02	2.17	4.63
	1934	6.23	11.33	27.14	28.26	2.30	2.23	4.52

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[a] 15 minutes

Over all types of transient cycle and steady-state operation, HC emissions were generally lowest for bus 2162, higher for bus 2126, and highest for bus 1934. The lowest HC emissions level was noted over cold-start transient test operation for bus 2162, and the highest fuel specific HC emissions level was found for idle operation of bus 1934. Carbon monoxide emissions appeared to be very cycle-sensitive. The highest level of CO was noted from bus 2162 on the unfiltered bus cycle, and yet CO from this bus was lowest on the 40 kph steady-state.

Oxides of nitrogen were determined by both bag and continuous methods. NO_x emissions determined by continuous methods yielded from equal to 10 percent higher levels of NO_x as compared to bag sample analysis. Trends for NO_x emissions from the three buses were just the opposite of trends noted for HC. Namely, NO_x emissions were highest for bus 2162, lower for bus 2126, and lowest for bus 1934. On a fuel specific basis, NO_x emissions were greatest during idle for all three buses, but at idle, mass emissions of NO_x is low. For a given bus over the various cycles, emissions of NO_x tended to be low whenever emissions of HC and CO were high.

Particulate emissions from the three buses ranged from a low of 1.20 g/kg fuel for bus 2126 over the 20 kph steady-state, to a high of 7.91 g/kg fuel for bus 1934 on the unfiltered bus cycle. Just the opposite of NO_x emissions, particulate emissions tended to be high whenever HC and CO emissions were relatively high. Particulate emissions were generally lower for bus 2126 on No. 1 fuel, higher for bus 2162 on No. 2 fuel, and highest for bus 1934 on No. 1 fuel. Recall that buses 2162 and 1934 had similar oil consumption, higher than bus 2126.

Comparing cold-start transient to hot-start transient results showed some cold-start sensitivity. Emissions of NO_x were lower for the cold-start. Particulate emissions and fuel consumption were greater on the cold-start. HC and CO emissions on both the cold- and hot-start transient tests were similar.

Comparison of composite transient emission levels to those obtained from the filtered bus cycle indicate generally higher HC emissions on the filtered bus cycle, except on bus 2162. Emission of CO was generally lower over the filtered bus cycle than for the composite transient, especially for bus 2162. Emissions of NO_x over the filtered bus cycle were about 20 percent higher than over the transient cycle. Total particulate emissions were 15 to 40 percent lower on the filtered bus cycles. Fuel economy was slightly worse on the filtered bus cycle than for the transient cycle.

Comparing results obtained on the filtered and unfiltered bus cycles indicates that operation over the unfiltered bus cycle, with its rapid throttle fluctuations, caused dramatic increase in CO and particulate emissions (except for bus 2126). Unexpectedly, lower emissions of HC and NO_x were obtained on the unfiltered bus cycle. Poorer fuel economy was also noted over the unfiltered bus cycle compared to the filtered version. The Central Business District cycle resulted in emission levels similar to those obtained for the unfiltered bus cycle, but with lower fuel economy. Emissions measured over the three steady-state conditions indicated higher levels of HC and NO_x than from the various transient operations. In contrast, the steady-state emissions of CO and particulate were generally lower than from the transient cycles.

Selected individual hydrocarbons were determined over the cold- and hot-start chassis transient tests, and over the filtered bus cycle. Results from analysis of CVS-diluted exhaust gases are given in Tables 67, 68, and 69 for buses 2162, 2126, and 1934, respectively. From analysis for eight different hydrocarbon species, only methane and ethylene were noted for all three buses. Some benzene and toluene were noted for one of the cold-start transient test conducted on bus 2126. Levels of methane and ethylene were greatest for bus 1934. Ethylene emissions were about the same for 2162 and 2126.

Aldehydes were also determined over the cold- and hot-start chassis transient cycles, and over the filtered bus cycle. In addition, aldehydes were determined for three steady-state conditions. Aldehyde results from analysis of CVS-diluted exhaust gases are given in Tables 70, 71, and 72 for buses 2162, 2126, and 1934, respectively. In all cases, formaldehyde made up the bulk of the aldehydes noted from the three buses. Generally, the aldehyde levels measured on the cold-start transient were higher than for the hot-start transient. The levels noted for the bus cycle were similar to the levels for the cold-start transient cycle. For all three buses, the totals of aldehyde emissions over the steady-state conditions were highest for idle, followed by the 20 kph condition, and then the 40 kph condition.

Smoke opacity was monitored continuously during chassis dynamometer operation with an in-line smokemeter. Table 73 summarizes the integrated smoke opacities over the various operating cycles and conditions. Overall, most of the integrated values were near or below 5 percent opacity. Exhaust plumes with opacity levels below 3-4 percent are essentially invisible to the human eye. Although many of the integrated smoke opacities in Table 73 were below this level, there were many peaks which exceeded 10 percent opacity during transient test work. These peaks, combined with low levels of smoke opacity during idle (1.0 percent) yielded relatively low integrated smoke opacity levels over the entire cycles. Over the cold- and hot-start transient cycle, smoke emissions were highest for bus 1934 (run on No. 1 fuel), lower for bus 2162, and least for bus 2126. For all three buses, smoke opacity over the filtered bus cycle was lower than for the transient cycle. Smoke opacity for all three buses on the unfiltered bys cycle was higher than obtained on the filtered bus cycle. Results over the CBD cycle resembled those obtained on the hot-start transient cycle. For steady-state operation, smoke opacities were all below 2 percent. Overall, smoke emissions were less cycle-dependent for bus 2126 than for the other two buses.

Smoke opacities over a series of short tests were determined for all three buses, and are summarized in Table 74. Smoke levels during "idle" in neutral were minimal for all three buses. "Snap idle" smoke opacity was relatively high for bus 2162, but low for bus 2126. After "snap idle," "stall" smoke opacity was surprisingly low for bus 2162. In addition, the difference between stall smoke opacity from buses 2126 and 1934 was greater than expected, considering that both these buses were run on No. 1 fuel.

TABLE 67. SUMMARY OF IHC FROM BUS NO. 2162

Emission Test		Selected Individual Hydrocarbons[c] from Bus No. 2162			
		Methane		Ethylene	
Cycle	No.	mg/km	mg/kg fuel[a]	mg/km	mg/kg fuel[a]
Cold Start Transient	1	1.6	2.7	50	110
	2	15	34	55	120
	Avg	8.3	18	52	120
Hot Start Transient	1	11	28	53	130
	2	0.6	1.4	52	130
	Avg	5.8	15	52	130
Bus Cycle Filtered	1	0[b]	0[b]	47	110
	2	24	57	58	140
	Avg	12	28	52	120

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[a] Fuel specific emissions based on fuel usage by carbon balance

[b] Bakcground levels exceeded sample levels

[c] Analysis includes determination of methane, ethylene, ethane, acetylene, propane, propylene, benzene, and toluene. For Bus No. 2162, only methane and ethylene were noted above background levels

TABLE 68. SUMMARY OF IHC FROM BUS NO. 2126

Emission Test		Selected Individual Hydrocarbons[c,d] from Bus No. 2126			
		Methane		Ethylene	
Cycle	No.	mg/km	mg/kg fuel[a]	mg/km	mg/kg fuel[a]
Cold Start Transient	1	15	39	56	140
	2	12	30	53	130
	Avg	14	34	54	140
Hot Start Transient	1	0[b]	0[b]	43	120
	2	0[b]	0[b]	46	130
	Avg	0[b]	0[b]	44	120
Bus Cycle Filtered	1	0[b]	0[b]	63	160
	2	0[b]	0[b]	72	180
	Avg	0[b]	0[b]	68	170

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[a] Fuel specific emissions based on fuel usage by carbon balance

[b] Background levels exceeded sample levels

[c] Analysis includes determination of methane, ethylene, ethane, acetylene, propane, propylene, benzene and toluene. For Bus No. 2126, only methane and ethylene and some benzene and toluene were noted above background levels

[d] On first cold-start transient: benzene levels were 35 mg/km and 87 mg/kg fuel and toluene levels were 93 mg/km and 230 mg/kg fuel. These individual hydrocarbons were not noted over any other runs for Bus No. 2126.

TABLE 69. SUMMARY OF IHC FROM BUS NO. 1934

Emission Test		Selected Individual Hydrocarbons[b] from Bus No. 1934			
		Methane		Ethylene	
Cycle	No.	mg/km	mg/kg fuel[a]	mg/km	mg/kg fuel[a]
Cold	1	22	51	93	220
Start	2				
Transient	Avg[c]				
Hot	1	72	190	78	200
Start	2				
Transient	Avg[c]				
Bus	1	160	400	100	250
Cycle	2				
Filtered	Avg[c]				

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[a] Fuel specific emissions based on fuel usage by carbon balance

[b] Analysis includes determination of methane, ethylene, ethane, acetylene, propane, propylene, benzene, and toluene. For Bus No. 1934, only methane and ethylene were noted above background levels

[c] Single tests, no replicates

[c] Single tests, no replicates

TABLE 70. SUMMARY OF ALDEHYDE EMISSIONS FROM OPERATION OF BUS NO. 2162

Aldehyde	Bus No.	Cold-Start Transient		Hot-Start Transient		Bus Cycle Filtered		Idle In-Drive		20 kph Steady-State		40 kph Steady-State	
		mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel
Formaldehyde	1	170	370	47	120	100	230	—	170	49	160	29	120
	2	120	280	110	270	170	390	—	310	67	220	50	210
	Avg	140	320	78	200	140	310	—	240	58	190	40	160
Acetaldehyde	1	69	150	37	91	50	110	—	63	21	67	8.9	36
	2	31	70	1.0	2.6	0	0	—	15	0	0	0.79	3.3
	Avg	50	110	19	47	25	55	—	39	10	34	4.8	19.6
Acetone	1	50	110	12	31	36	83	—	40	32	100	9.7	40
	2	15	35	20	51	7.3	17	—	100	8.6	28	9.8	41
	Avg	32	72	16	41	22	50	—	70	20.	64	9.8	40
Propionaldehyde	1	7.1	16	0	0	0	0	—	0	9.2	29	0	0
	2	0	0	0	0	13	31	—	52	0	0	0	0
	Avg	3.6	8.0	0	0	6	16	—	26	4.6	14	0	0
Crotonaldehyde	1	37	82	30	74	25	57	—	43	12	40	1.1	4.4
	2	4.9	11	0.04	0.10	0	0	—	0	1.9	6.1	3.4	14
	Avg	21.	46	15	37	12	28	—	22	7.0	23	2.3	9.2
Isobutyraldehyde & Methylethylketone	1	21	47	2.4	5.9	49	110	—	43	28	88	7.0	29
	2	7.2	16	24	26	60	140	—	160	9.8	32	12	51
	Avg	14.	32	13	34	54	120	—	100	19	60	9.5	40
Benzaldehyde	1	0	0	0	0	0	0	—	0	36	110	11	44
	2	0	0	0	0	0	0	—	0	0	0	0	0
	Avg	0	0	0	0	0	0	—	0	18	55	6	22
Hexanaldehyde	1	47	100	3.8	9.5	0	0	—	0	18	60	16	67
	2	33	75	2.2	5.6	23	54	—	57	2.6	8.3	17	71
	Avg	40	88	3.0	7.6	12	27	—	28	10.	34.	16	69
Total of Average		300	680	150	370	270	610	—	520	150	470	88	360

TABLE 71. SUMMARY OF ALDEHYDE EMISSIONS FROM OPERATION OF BUS NO. 2126

Aldehyde	Bus No.	Cold-Start Transient mg/km	Cold-Start Transient mg/kg fuel	Hot-Start Transient mg/km	Hot-Start Transient mg/kg fuel	Bus Cycle Filtered mg/km	Bus Cycle Filtered mg/kg fuel	Idle mg/km	In-Drive mg/kg fuel	20 kph Steady-State mg/km	20 kph Steady-State mg/kg fuel	40 kph Steady-State mg/km	40 kph Steady-State mg/kg fuel
Formaldehyde	1	180	450	30	370	150	380	--	430	91	330	45	210
	2	150	350	110	300	160	410	--	380	100	350	40	180
	Avg	160	400	120	304	160	400	--	400	96	340	42	200
Acetaldehyde	1[a]	80	200	32	90	43	110	--	200	32	110	12	58
	2	--	--	--	--	--	--	--	--	--	--	--	--
	Avg	80	200	32	90	43	110	--	200	32	110	12	58
Acetone	1	90	230	36	100	52	130	--	210	30	110	18	84
	2	35	85	36	99	31	78	--	50	41	140	12	55
	Avg	62	160	36	100	42	100	--	130	36	120	15	70
Propionaldehyde	1	0	0	0	0	0	0	--	0	0	0	0	0
	2	0	0	0	0	0	0	--	0	0	0	0	0
	Avg	0	0	0	0	0	0	--	0	0	0	0	0
Crotonaldehyde	1	12	31	3.6	10	0	0	--	100	0	0	1.7	8.1
	2	0	0	0	0	0	0	--	0	0	0	0	0
	Avg	6	16	1.8	5	0	0	--	50	0	0	0.85	4.0
Isobutyraldehyde & Methylethylketone	1	40	100	19	54	1.2	3.0	--	17	0	0	8.2	38
	2	3.3	8.1	25	69	1.9	4.7	--	59	23	80	1.0	4.8
	Avg	22	54	22	62	1.6	3.8	--	38	12	40	4.6	21
Benzaldehyde	1	14	36	0	0	0	0	--	26	0	0	2.3	11
	2	6.7	16	23	63	0	0	--	0	0	0	2.4	11
	Avg	10.	26	12	32	0	0	--	13	0	0	2.4	11
Hexanaldehyde	1	0	0	0	0	0	0	--	53	0	0	4.2	20
	2	22	55	13	37	0	0	--	0	0	0	0	0
	Avg	11	28	6	18	0	0	--	26	0	0	2.1	10
Total of Average		350	880	230	650	250	610	--	860	180	610	79	370

---

[a] Contaminated blank

TABLE 72. SUMMARY OF ALDEHYDE EMISSIONS FROM OPERATION OF BUS NO. 1934

Aldehyde	Cold-Start Transient		Hot-Start Transient		Bus Cycle Filtered		Idle In-Drive		20 kph Steady-State		40 kph Steady-State	
	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel	mg/km	mg/kg fuel
Formaldehyde	200	480	110	280	140	330	--	390	80	290	41	180
Acetaldehyde[a]	—	—	—	—	—	—	--	—	—	—	—	—
Acetone	17	41	0	0	42	100	--	88	17	60	4.7	21
Propionaldehyde	0	0	0	0	0	0	--	0	0	0	0	0
Crotonaldehyde	0	0	0	0	0	0	--	0	0	0	0	0
Isobutyraldehyde & Methylethylketone	0	0	0	0	0	0	--	0	0	0	0	0
Benzaldehyde	0	0	0	0	0	0	--	50	0	0	0	0
Hexanaldehyde	0	0	13	35	22	53	--	16	0	0	0	0
Total	220	520	120	320	200	480	--	540	97	350	46	200

---

[a] Contaminated blank

TABLE 73. SUMMARY OF INTEGRATED SMOKE OPACITY FROM OPERATION OF BUSES ON CHASSIS DYNAMOMETER

Test		Smoke Opacity, Percent		
Cycle	No.	Bus 2162[a]	Bus 2126[b]	Bus 1934[b]
Cold Start Transient	1	2.4[c]	2.4[d]	5.5[e]
	2	2.6	2.4	---
	Avg	2.5[c]	2.4[d]	5.5[e]
Hot Start Transient	1	3.6[c]	2.0[d]	4.0[e]
	2	2.3[d]	2.3[d]	4.0[e]
	Avg	3.0[c]	2.2[d]	4.0[e]
Bus Cycle Filtered	1	2.0[c]	1.8[d]	2.5[e]
	2	1.9[c]	1.8[d]	---
	Avg	2.0[c]	1.8[d]	2.5[e]
Bus Cycle Unfiltered	1	5.9[c]	2.1[d]	3.7[e]
	2	4.5[c]	1.9[d]	---
	Avg	5.2[c]	2.0[d]	3.7[e]
Central Business District	1	---	2.0	4.5
	2	---	2.3	---
	Avg	---	2.2	4.5
Idle In-Drive	1	1.0	1.0	1.0
	2	1.1	1.0	---
	Avg	1.0	1.0	1.0
20 kph Steady-State	1	1.1	1.0	2.0
	2	0.8	1.0	---
	Avg	1.0	1.0	2.0
40 kph Steady-State	1	0.9	1.0	2.0
	2	1.0	1.0	---
	Avg	1.0	1.0	2.0

---

[a] No. 2 Emissions Fuel

[b] No. 1 Emissions Fuel

[c] Smoke trace contained some peaks ranging from 15 to 30 percent smoke opacity

[d] Smoke trace contained few sharp peaks, maximums were near 10 percent smoke opacity

[e] Smoke trace contained very many sharp peaks, maximums were near 15 percent smoke opacity

TABLE 74. SUMMARY OF RESULTS OBTAINED OVER SHORT-TESTS[a] FOR SMOKE

Test Condition		Smoke Opacity, Percent		
		Bus 2162[b]	Bus 2126[c]	Bus 1934[c]
Idle[d] In-Neutral		1.0	0.8	0.9
Snap[e] Idle	1	35.2	7.0	19.5
	2	33.1	6.5	24.5
	3	33.0	7.1	23.2
	Avg	33.8	6.9	22.4
Stall[f]		4.5	5.6	14.8

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[a] Sort-tests based on work reported in Reference 30

[b] No. 2 Emissions Fuel

[c] No. 1 Emissions Fuel

[d] Smoke opacaity measured at curbe idle speed in netrual gear

[e] Peak smoke opacities over W.O.T. acceleration of engine speed from curb idle to governed maximum speed while in neutral gear, three times in rapid succession

[f] Smoke opacity measured when engine achieves maximum rpm with full throttle, transmission in drive and vehicle stationary

The sulfate portion of the total particulate emissions was determined using the BCA method, and the results are summarized in Table 75. For all three buses, sulfate emissions over the cold-start transient cycle were higher than for the hot-start transient cycle. Comparing transient composite sulfate levels, bus 2162 had almost 4 times the level of sulfate found for buses 2126 and 1934. Bus 2162 was operated on No. 2 diesel fuel containing 0.35 weight percent sulfur, and buses 2126 and 1934 were operated on No. 1 diesel fuel containing 0.17 weight percent sulfur. For bus 2162, sulfate emissions on the filtered bus cycle were almost half the level obtained for the transient composite. For buses 2126 and 1934, sulfate emission levels for the filtered bus cycle were similar to the transient composite levels.

TABLE 75. SUMMARY OF SULFATE EMISSIONS

Emissions Test		Bus No. 2162			Bus NO. 2126			Bus No. 1934[b]		
		Sulfate		% S[c]	Sulfate		% S[c]	Sulfate		% S[c]
Cycle	No.	mg/km	mg/kgf[d]	Rec.	mg/km	mg/kgf[d]	Rec.	mg/km	mg/kgf[d]	Rec.
Cold	1	100	240	2.2	29	74	1.4	46	110	2.1
Start	2	---[a]	---[a]	---[a]	24	58	1.1	--	---	---
Trans.	Avg	110	240	2.2	26	66	1.2	46	110	2.1
Hot	1	82	200	1.9	25	69	1.4	23	60	1.2
Start	2	95	240	2.3	16	45	0.9	--	--	---
Trans.	Avg	88	220	2.1	20	57	1.2	23	60	1.2
Composite Transient		91	220	2.1	21	58	1.2	26	67	1.3
Bus	1	67	150	1.5	21	53	1.0	26	64	1.3
Cycle	2	48	110	1.1	14	34	0.7	--	--	---
Filt.	Avg	58	130	1.3	18	44	0.8	26	64	1.3

---

[a] Sample void
[b] No replicate run
[c] Percent of fuel sulfur conversion to sulfate
[d] mg/kg fuel, based on carbon balance fuel

Samples of total particulate were extracted with methylene chloride to determine the soluble organic fraction (SOF) of the particulate. Results from determinations of SOF from all three buses are summarized in Table 76. The percentages of SOF over transient cycle operation for buses 2162 and 2126 were similar and the percentage of SOF for bus 1934 was substantially lower. When the rate of total particulate emissions is considered, hot-start transient SOF emissions from buses 2126 and 1934 were similar; whereas, SOF emissions from bus 2162 were nearly 1.4 times greater. On the filtered bus cycle, SOF emissions were slightly lower than on the transient cycle for buses 2162 and 2126, but were substantially lower for bus 1934.

TABLE 76. SUMMARY OF SOLUBLE ORGANIC FRACTION (SOF) RESULTS FROM TRANSIENT CHASSIS TESTING

Emissions Test		Bus No. 2162[a]			Bus No. 2126[b]			Bus No. 1934[b]		
			SOF			SOF			SOF	
Cycle	No.	%	g/km	g/kg fuel[c]	%	g/km	g/kg fuel[c]	%	g/km	g/kg fuel[c]
Cold	1	21.4	0.38	0.84	25.4	0.30	0.77	16.8	0.54	1.28
Start	2	24.7	0.49	1.12	28.1	0.35	0.87	----	----	----
Trans.	Avg	23.0	0.44	0.98	26.8	0.32	0.82	16.8	0.54	1.28
Hot	1	25.2	0.41	1.01	22.3	0.23	0.64	10.2	0.24	0.61
Start	2	21.8	0.32	0.83	26.2	0.24	0.66	----	----	----
Trans.	Avg	23.5	0.36	0.92	24.2	0.24	0.65	10.2	0.24	0.61
Bus	1	35.1	0.41	0.95	23.2	0.21	0.53	5.2	0.11	0.27
Cycle	2	30.5	0.27	0.64	23.5	0.19	0.48	----	----	----
Filtered	Avg	32.8	0.34	0.80	23.4	0.20	0.50	5.2	0.11	0.27

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[a] No. 2 Emissions Fuel

[b] No. 1 Emissions Fuel

[c] Fuel specific emissions based on fuel usage by carbon balance

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APPENDIX A

TEST RESULTS FROM THE MACK ETAY(B) 673A

TABLE A-1. 1974 13-MODE EMISSIONS RESULTS WITHOUT WATER

13-MODE FEDERAL DIESEL EMISSION CYCLE

PROJECT : 11-5428-001 DATE 1-8-79 TEST NO. 1
ENGINE : MACK ETAY(B)-673A WITHOUT H2O APE PUMP

MODE	ENGINE SPEED RPM	TORQUE N X M	POWER KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	EXHAUST FLOW KG/MIN	FUEL AIR RATIO
1	650	0.0	0.0	.017	3.84	3.86	.005
2	1450	30.9	4.7	.074	9.63	9.70	.008
3	1450	339.5	51.5	.216	10.76	10.98	.020
4	1450	686.1	104.2	.385	13.84	14.22	.028
5	1450	1046.9	158.9	.571	17.28	17.85	.033
6	1450	1391.1	211.2	.773	21.01	21.78	.037
7	650	0.0	0.0	.017	3.89	3.91	.004
8	1900	1175.1	233.8	.927	27.67	28.60	.033
9	1900	890.2	177.1	.680	23.56	24.24	.029
10	1900	605.3	120.4	.475	19.56	20.03	.024
11	1900	306.2	60.9	.279	15.60	15.88	.018
12	1900	33.2	6.6	.117	12.82	12.94	.009
13	650	0.0	0.0	.017	3.94	3.96	.004

MODE	HC PPM	CO+ PPM	NO++ PPM	WEIGHTED KW	BSHC G/KW HR	BSCO+ G/KW HR	BSNO2++ G/KW HR	HUM. MILLI G/KG
1	164	254	256	0.00	R	R	R	4.4
2	264	226	243	.37	15.91	27.10	47.94	4.4
3	231	137	541	4.12	1.43	1.69	10.98	4.4
4	199	129	887	8.33	.79	1.02	11.54	4.4
5	94	226	1061	12.72	.31	1.47	11.35	4.4
6	64	340	1109	16.90	.19	2.03	10.89	4.4
7	154	136	284	0.00	R	R	R	4.4
8	66	258	722	18.70	.23	1.83	8.42	4.4
9	114	173	623	14.17	.45	1.37	8.13	4.4
10	176	118	440	9.63	.85	1.14	6.97	4.4
11	206	149	264	4.87	1.56	2.26	6.54	4.4
12	263	180	141	.53	14.97	20.45	26.34	4.4
13	169	182	219	0.00	R	R	R	4.4

CYCLE COMPOSITE BSHC = .707 GRAM/KW HR
BSCO+ = 1.924 GRAM/KW HR
BSNO2++= 9.875 GRAM/KW HR
BSHC + BSNO2++= 10.582 GRAM/KW HR
BSFC = .241KG/KW HR

+ CONVERTED TO WET BASIS
++ CONVERTED TO WET BASIS AND CORRECTED TO 10.7 MILLIGRAMS WATER PER KG DRY AIR

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TABLE A-2. 1974 13-MODE EMISSIONS RESULTS WITH WATER

13-MODE FEDERAL DIESEL EMISSION CYCLE

PROJECT : 11-5428-001 DATE 1-8-79 TEST NO. 1
ENGINE : MACK ETAY(B)-673A WITH H_2O APE PUMP

MODE	ENGINE SPEED RPM	TORQUE N X M	POWER KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	EXHAUST FLOW KG/MIN	FUEL AIR RATIO
1	650	0.0	0.0	.017	4.00	4.02	.004
2	1450	30.9	4.7	.074	9.55	9.62	.008
3	1450	339.5	51.5	.216	10.79	11.00	.020
4	1450	686.1	104.2	.385	13.44	13.83	.029
5	1450	1046.9	158.9	.569	16.76	17.33	.034
6	1450	1391.1	211.2	.773	20.28	21.06	.038
7	650	0.0	0.0	.017	3.77	3.79	.005
8	1900	1175.1	233.8	.926	26.83	27.76	.035
9	1900	890.2	177.1	.681	23.03	23.71	.030
10	1900	605.3	120.4	.475	19.15	19.63	.025
11	1900	306.2	60.9	.279	14.84	15.12	.019
12	1900	33.2	6.6	.117	12.66	12.78	.009
13	650	0.0	0.0	.017	3.78	3.79	.005

MODE	HC PPM	CO+ PPM	NO++ PPM	WEIGHTED KW	BSHC G/KW HR	BSCO+ G/KW HR	BSNO2++ G/KW HR	HUM. MILLI G/KG
1	320	626	132	0.00	R	R	R	4.4
2	320	528	166	.37	19.13	62.86	32.47	4.4
3	255	208	452	4.12	1.58	2.57	9.20	4.4
4	178	85	725	8.33	.69	.66	9.17	4.4
5	136	132	783	12.72	.43	.83	8.12	4.4
6	84	261	789	16.90	.24	1.51	7.49	4.4
7	272	431	151	0.00	R	R	R	4.4
8	68	183	553	18.70	.23	1.26	6.26	4.4
9	92	125	498	14.17	.36	.97	6.35	4.4
10	136	118	410	9.63	.64	1.11	6.36	4.4
11	176	202	267	4.87	1.27	2.90	6.31	4.4
12	320	489	125	.53	18.00	54.80	23.02	4.4
13	300	569	126	0.00	R	R	R	4.4

CYCLE COMPOSITE
BSHC = .743 GRAM/KW HR
BSCO+ = 2.118 GRAM/KW HR
BSNO2++= 7.499 GRAM/KW HR
BSHC + BSNO2++= 8.243 GRAM/KW HR
BSFC = .241KG/KW HR

+ CONVERTED TO WET BASIS
++ CONVERTED TO WET BASIS AND CORRECTED TO 10.7 MILLIGRAMS WATER PER KG DRY AIR

TABLE A-3. 1979 13-MODE EMISSIONS RESULTS WITHOUT WATER

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

PROJECT : 11-5428-001 DATE 1-8-79 TEST NO.1
ENGINE : MACK ETAY(B)-673A WITHOUT H2O APE PUMP

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 650	0	0.0	.02	3.81	4.4	.888	164	258	1.91	290	12	37	61	1
2	2	INTER / 1450	31	4.7	.07	9.49	4.4	.891	264	231	1.93	275	60	104	180	2
3	25	INTER / 1450	340	51.6	.22	10.64	4.4	.903	231	144	4.79	625	65	77	497	3
4	50	INTER / 1450	686	104.2	.38	13.74	4.4	.910	199	138	6.88	1037	71	92	1033	4
5	75	INTER / 1450	1047	159.0	.57	17.22	4.4	.915	94	244	8.27	1250	42	201	1546	5
6	100	INTER / 1450	1391	211.3	.77	20.93	4.4	.918	64	369	9.30	1312	35	366	1962	6
7		IDLE / 650	0	0.0	.02	3.89	4.4	.888	154	138	1.25	325	13	22	77	7
8	100	RATED / 1900	1175	233.9	.93	27.38	5.4	.927	66	278	8.91	850	47	365	1702	8
9	75	RATED / 1900	890	177.2	.68	23.47	5.4	.923	114	185	7.04	732	71	213	1280	9
10	50	RATED / 1900	605	120.5	.47	19.56	5.4	.920	176	125	5.89	515	90	120	747	10
11	25	RATED / 1900	306	60.9	.28	15.59	5.4	.914	206	156	4.30	307	83	120	355	11
12	2	RATED / 1900	33	6.6	.12	12.73	5.4	.908	263	185	2.19	162	85	116	152	12
13		IDLE / 650	0	0.0	.02	3.92	5.4	.904	164	185	1.19	250	15	31	63	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	'PHI'	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	11.47	35.46	58.17	R	R	R	.0046	.0677	.068	.984	.0070		.964	R	.067	1
2	13.61	23.29	40.60	12.91	22.08	38.50	.0078	.0677	.116	.980	.0095		.971	.977	.080	2
3	5.02	5.95	30.32	1.26	1.50	9.64	.0204	.0677	.301	.953	.0228		.974	.258	.080	3
4	3.08	3.98	44.75	.68	.88	9.91	.0281	.0677	.416	.934	.0324		.982	.226	.080	4
5	1.23	5.87	45.16	.26	1.26	9.72	.0333	.0677	.492	.922	.0386		.992	.217	.080	5
6	.75	7.88	42.30	.16	1.73	9.29	.0371	.0677	.548	.914	.0432		1.004	.219	.080	6
7	12.21	21.53	74.01	R	R	R	.0045	.0677	.066	.986	.0062		.968	R	.067	7
8	.85	6.57	30.62	.20	1.56	7.28	.0340	.0677	.502	.921	.0392		1.026	.232	.080	8
9	1.73	5.22	31.36	.40	1.20	7.22	.0291	.0677	.430	.933	.0331		1.014	.227	.080	9
10	3.15	4.21	26.23	.75	1.00	6.20	.0244	.0677	.360	.943	.0279		1.002	.236	.080	10
11	4.96	7.18	21.23	1.36	1.97	5.83	.0180	.0677	.265	.958	.0206		.991	.277	.080	11
12	12.04	16.52	21.57	12.80	17.56	22.93	.0092	.0677	.137	.977	.0107		.981	1.083	.080	12
13	13.98	30.14	60.97	R	R	R	.0045	.0677	.066	.987	.0054		.968	R	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.603 GRAM/KW-HR	(.450	GRAM/BHP-HR)
BSCO ------- =	1.638 GRAM/KW-HR	(1.222	GRAM/BHP-HR)
BSNOX ------ =	8.518 GRAM/KW-HR	(6.354	GRAM/BHP-HR)
BSHC + BSNOX =	9.121 GRAM/KW-HR	(6.804	GRAM/BHP-HR)
CORR. BSFC - =	.240 KG/KW-HR	(.395	LBS/BHP-HR)

TABLE A-4. 1979 13-MODE EMISSIONS RESULTS WITH WATER

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

PROJECT : 11-5428-001 DATE 1-8-79 TEST NO.1
ENGINE : MACK ETAY(B)-673A WITH H2O APE PUMP

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 650	0	0.0	.02	3.98	4.4	.888	320	636	1.38	150	23	90	31	1
2	2	INTER / 1450	31	4.7	.07	9.51	4.4	.891	320	540	1.91	190	73	240	124	2
3	25	INTER / 1450	340	51.6	.22	10.75	4.4	.903	255	218	4.74	525	72	118	421	3
4	50	INTER / 1450	686	104.2	.38	13.39	4.4	.911	178	91	7.04	850	62	59	829	4
5	75	INTER / 1450	1047	159.0	.57	16.81	4.4	.915	136	142	8.37	925	60	115	1128	5
6	100	INTER / 1450	1391	211.3	.77	20.50	4.4	.919	84	284	9.41	937	45	278	1387	6
7		IDLE / 650	0	0.0	.02	3.81	4.4	.888	272	438	1.47	175	19	59	35	7
8	100	RATED / 1900	1175	233.9	.93	27.01	4.4	.916	68	198	8.57	655	48	255	1272	8
9	75	RATED / 1900	890	177.2	.68	23.18	4.4	.911	92	134	7.32	587	55	149	976	9
10	50	RATED / 1900	605	120.5	.47	19.21	4.4	.907	136	125	6.18	480	66	115	655	10
11	25	RATED / 1900	306	60.9	.28	14.95	4.4	.901	176	211	4.52	312	68	155	339	11
12	2	RATED / 1900	33	6.6	.12	12.75	4.4	.893	320	502	2.29	145	97	297	126	12
13		IDLE / 650	0	0.0	.02	3.80	4.4	.889	300	578	1.34	145	22	84	31	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	'PHI'	NET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	22.03	86.02	29.60	R	R	R	.0044	.0677	.065	.984	.0071		.966	R	.067	1
2	16.36	54.00	27.82	15.51	51.20	26.38	.0078	.0677	.116	.980	.0096		.974	.973	.080	2
3	5.59	9.09	32.45	1.41	2.29	8.16	.0202	.0677	.299	.953	.0227		.977	.257	.080	3
4	2.70	2.57	35.92	.60	.57	7.96	.0289	.0677	.426	.933	.0331		.985	.225	.080	4
5	1.76	3.38	33.07	.38	.72	7.09	.0340	.0677	.502	.922	.0390		.997	.215	.080	5
6	.97	6.00	29.90	.21	1.32	6.57	.0379	.0677	.560	.913	.0437		1.008	.218	.080	6
7	17.94	56.73	33.08	R	R	R	.0046	.0677	.068	.984	.0074		.972	R	.067	7
8	.86	4.60	22.89	.20	1.09	5.44	.0344	.0677	.509	.920	.0399		1.029	.231	.080	8
9	1.35	3.64	23.90	.31	.84	5.51	.0295	.0677	.436	.931	.0343		1.015	.227	.080	9
10	2.33	4.02	23.01	.55	.95	5.44	.0248	.0677	.367	.941	.0292		1.003	.236	.080	10
11	4.04	9.24	20.23	1.11	2.54	5.55	.0187	.0677	.277	.955	.0216		.992	.277	.080	11
12	13.82	42.24	17.89	14.68	44.88	19.01	.0092	.0677	.136	.976	.0114		.986	1.078	.080	12
13	21.33	80.80	29.59	R	R	R	.0046	.0677	.068	.985	.0069		.972	R	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

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BSHC --------- =   .620  GRAM/KW-HR    (  .462 GRAM/BHP-HR )
BSCO --------- =  1.749  GRAM/KW-HR    ( 1.305 GRAM/BHP-HR )
BSNOX -------- =  6.494  GRAM/KW-HR    ( 4.844 GRAM/BHP-HR )
BSHC + BSNOX   =  7.113  GRAM/KW-HR    ( 5.307 GRAM/BHP-HR )
CORR. BSFC - =    .239   KG/KW-HR      (  .394 LBS/BHP-HR  )
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TABLE A-5. ALDEHYDES BY DNPH FOR MACK ETAY(B) 673A WITH APE PUMP, WITHOUT WATER

		1450 rpm				1900 rpm		
Aldehyde	Rate	2	50	100	Idle	100	50	2
Form-aldehyde	µg/m^3	2481.0	2109.3	1635.4	2304.4	1598.2	1414.2	1793.4
	mg/hr	1560.5	1957.3	2250.4	579.2	3022.6	2491.9	1514.5
	mg/kg fuel	347.5	84.8	48.4	532.0	54.3	87.3	215.4
	mg/kW-hr	332.0	19.1	10.7	------	13.0	21.3	229.5
Acet-aldehyde	µg/m^3	201.8	0	0	0	0	0	693.6
	mg/hr	274.3	0	0	0	0	0	1266.0
	mg/kg fuel	61.1	0	0	0	0	0	180.1
	mg/kW-hr	58.4	0	0	0	0	0	191.8
Acetone	µg/m^3	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Isobutyr-aldehyde	µg/m^3	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Croton-aldehyde	µg/m^3	607.0	289.6	404.7	563.4	253.9	456.3	686.4
	mg/hr	2086.5	1468.7	3043.1	773.8	2624.3	3246.0	3167.6
	mg/kg fuel	464.6	63.6	65.5	710.8	47.1	113.8	450.5
	mg/kW-hr	443.9	14.3	14.4	------	11.3	27.7	479.9
Hexan-aldehyde	µg/m^3	0	0	0	0	0	0	183.5
	mg/hr	0	0	0	0	0	0	1726.4
	mg/kg fuel	0	0	0	0	0	0	245.5
	mg/kW-hr	0	0	0	0	0	0	261.6
Benz-aldehyde	µg/m^3	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0

TABLE A-6. ALDEHYDES BY DNPH FOR MACK ETAY(B)673A WITH APE PUMP, WITH WATER

		1450 rpm				1900 rpm		
Aldehyde	Rate	2	50	100	Idle	100	50	2
Formaldehyde	μg/m^3	4125.7	1523.9	1431.0	8864.7	1412.4	1347.4	4209.3
	mg/hr	2578.5	1358.9	1964.3	2264.1	2371.8	1554.8	3554.8
	mg/kg fuel	574.2	59.1	42.2	1996.5	42.5	54.6	505.6
	mg/kW-hr	548.6	13.0	9.2	------	10.0	13.2	538.6
Acetaldehyde	μg/m^3	1298.9	0	0	2169.1	0	0	996.3
	mg/hr	1754.6	0	0	1197.4	0	0	1818.4
	mg/kg fuel	390.7	0	0	1055.9	0	0	258.6
	mg/kW-hr	373.3	0	0	------	0	0	275.5
Acetone	μg/m^3	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Isobutyraldehyde	μg/m^3	0	0	0	163.0	0	0	81.5
	mg/hr	0	0	0	239.2	0	0	395.5
	mg/kg fuel	0	0	0	211.0	0	0	56.3
	mg/kW-hr	0	0	0	------	0	0	59.9
Crotonaldehyde	μg/m^3	0	0	0	0	0	0	253.9
	mg/hr	0	0	0	0	0	0	1171.8
	mg/kg fuel	0	0	0	0	0	0	166.7
	mg/kW-hr	0	0	0	0	0	0	177.6
Hexanaldehyde	μg/m^3	241.9	0	0	244.7	0	0	141.8
	mg/hr	1684.1	0	0	696.2	0	0	1334.0
	mg/kg fuel	375.0	0	0	613.9	0	0	189.7
	mg/kW-hr	358.3	0	0	------	0	0	202.1
Benzaldehyde	μg/m^3	0	0	168.6	893.3	774.7	0	126.5
	mg/hr	0	0	2884.4	2842.7	16209.4	0	1330.9
	mg/kg fuel	0	0	62.0	2506.8	290.8	0	189.3
	mg/kW-hr	0	0	13.5	------	68.5	0	201.6

TABLE A-7. SPECIFIC HYDROCARBON EMISSION RATES
MACK ETAY(B)673A WITH APE PUMP, WITHOUT WATER

		1450 rpm				1900 rpm		
Hydrocarbon	Rate	2	50	100	Idle	100	50	2
Methane CH_4	µg/m^3	1924.6	699.2	546.1	1451.8	519.4	692.6	1718.2
	mg/hr	903.1	484.1	560.6	272.2	732.9	672.6	1082.5
	mg/kg fuel	201.1	2.1	12.1	250.1	13.2	23.6	154.0
	mg/kW-hr	192.1	4.7	2.7	------	3.2	5.7	164.0
Ethylene C_2H_4	µg/m^3	5430.0	3274.3	6810.8	3233.5	8593.7	6432.1	6286.5
	mg/hr	2547.5	2266.2	6990.2	606.2	12122.3	6245.6	3959.8
	mg/kg fuel	567.3	98.2	150.3	556.8	217.6	218.9	563.2
	mg/kW-hr	542.0	22.1	33.1	------	52.3	53.3	600.0
Ethane C_2H_6	µg/m^3	99.9	0	0	62.4	0	0	99.9
	mg/hr	46.9	0	0	11.7	0	0	62.9
	mg/kg fuel	10.4	0	0	10.8	0	0	9.0
	mg/kW-hr	10.0	0	0	------	0	0	9.5
Acetylene C_2H_2	µg/m^3	514.2	0	801.1	286.9	1190.9	173.2	617.1
	mg/hr	241.0	0	821.3	53.7	1894.4	168.0	388.2
	mg/kg fuel	53.7	0	17.7	49.3	34.0	5.9	55.2
	mg/kW-hr	51.3	0	3.9	------	8.2	1.4	58.8
Propane C_3H_8	µg/m^3	28.8	0	0	0	0	0	0
	mg/hr	14.3	0	0	0	0	0	0
	mg/kg fuel	3.2	0	0	0	0	0	0
	mg/kW-hr	3.0	0	0	0	0	0	0
Propylene C_3H_6	µg/m^3	1812.0	1841.1	2318.8	1072.0	2779.1	3565.6	2371.3
	mg/hr	850.1	1274.2	2379.9	201.0	3920.2	3462.2	1493.6
	mg/kg fuel	189.3	55.2	51.2	184.6	70.4	121.3	212.4
	mg/kW-hr	180.9	12.4	11.3	------	16.9	29.6	226.3
Benzene[a] C_6H_6	µg/m^3							
	mg/hr							
	mg/kg fuel							
	mg/kW-hr							
Toluene[a] C_7H_8	µg/m^3							
	mg/hr							
	mg/kg fuel							
	mg/kW-hr							

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[a] could not be determined from chromatogram

TABLE A-8. SPECIFIC HYDROCARBON EMISSION RATES MACK ETAY(B)673A WITH APE PUMP, WITH WATER

Hydrocarbon	Rate	1450 rpm			Idle	1900 rpm		
		2	50	100		100	50	2
Methane CH_4	µg/m^3	2663.8	1012.2	845.8	4009.0	819.1	765.8	3949.1
	mg/hr	1242.0	673.4	866.1	763.9	1026.2	659.3	2488.0
	mg/kg fuel	276.6	29.3	18.6	673.6	18.4	23.1	353.9
	mg/kW-hr	264.3	6.5	4.0	509.3	4.3	5.6	377.0
Ethylene C_2H_4	µg/m^3	9706.4	2138.2	8844.2	12561.3	11034.8	2872.3	11203.8
	mg/hr	4524.7	1422.1	9055.1	2392.9	13821.4	2472.3	7057.1
	mg/kg fuel	1007.6	61.8	194.8	2110.2	247.9	86.8	1003.7
	mg/kW-hr	962.7	13.6	42.3	1595.3	58.4	21.0	1069.3
Ethane C_2H_6	µg/m^3	174.8	0	0	237.2	0	0	206.0
	mg/hr	81.5	0	0	45.2	0	0	129.8
	mg/kg fuel	18.2	0	0	39.9	0	0	18.5
	mg/kW-hr	17.3	0	0	30.1	0	0	19.7
Acetylene C_2H_2	µg/m^3	909.4	167.8	893.1	1028.5	925.6	189.5	1093.4
	mg/hr	423.4	111.5	913.4	195.7	1158.0	162.9	687.9
	mg/kg fuel	94.3	4.8	19.6	172.6	20.8	5.7	97.8
	mg/kW-hr	90.1	1.1	4.3	130.5	4.9	1.4	104.2
Propane C_3H_8	µg/m^3	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Propylene C_3H_6	µg/m^3	2878.1	891.4	2709.2	3431.6	3245.2	1351.7	3431.6
	mg/hr	1341.7	592.9	2773.8	653.7	4064.7	1163.4	2161.5
	mg/kg fuel	298.8	25.8	59.7	576.5	72.9	40.8	307.4
	mg/kW-hr	285.5	5.7	13.0	435.8	17.2	9.9	327.5
Benzene[a] C_6H_6	µg/m^3							
	mg/hr							
	mg/kg fuel							
	mg/kW-hr							
Toluene[a] C_7H_8	µg/m^3							
	mg/hr							
	mg/kg fuel							
	mg/kW-hr							

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[a] could not be determined from chromatogram

TABLE A-9. SUMMARY OF EXHAUST PARTICULATE FROM MACK ETAY(B) 673A WITH APE PUMP WITHOUT WATER
(Based on 47 mm Pallflex Media)

Engine rpm/load %	Run	Concentration mg/m^3	Particulate Rate g/hr	Particulate Rate g/kg fuel	Particulate Rate g/kW/hr
1450/2	1	15.61	7.59	1.73	1.52
	2	14.76	6.88	1.56	1.38
	Avg	15.19	7.24	1.65	1.45
1450/25	1	29.96	16.27	1.26	0.32
	2	32.24	17.40	1.36	0.34
	Avg	31.10	16.84	1.31	0.33
1450/50	1	64.63	43.42	1.90	0.42
	2	69.35	46.18	2.01	0.45
	Avg	66.99	44.80	1.96	0.44
1450/75	1	135.48	115.83	3.40	0.74
	2	131.30	111.15	3.26	0.71
	Avg	133.39	113.49	3.33	0.73
1450/100	1	219.72	226.48	4.88	1.05
	2	190.65	198.46	4.28	0.92
	Avg	205.19	212.47	4.58	0.99
Idle	1	11.87	2.26	2.09	----
	2	11.06	2.08	1.89	----
	Avg	11.47	2.17	1.97	----
1900/100	1	98.44	135.00	2.42	0.59
	2	97.09	131.67	2.36	0.57
	Avg	97.77	133.34	2.39	0.58
1900/75	1	76.80	92.15	2.26	0.53
	2	80.72	96.21	2.36	0.55
	Avg	78.76	94.18	2.31	0.54
1900/50	1	75.83	74.52	2.61	0.65
	2	80.19	78.70	2.76	0.69
	Avg	78.01	76.61	2.69	0.67
1900/25	1	50.99	39.24	2.34	0.69
	2	62.24	48.02	2.88	0.86
	Avg	56.62	43.63	2.61	0.78
1900/2	1	21.94	13.81	1.95	2.66
	2	21.08	13.38	1.88	2.57
	Avg	21.51	13.60	1.92	2.62

TABLE A-10. SUMMARY OF EXHAUST PARTICULATE FROM MACK ETAY(B) 673A WITH APE PUMP WITH WATER

(Based on 47 mm Pallflex Media)

Engine rpm/load %	Run	Concentration mg/m^3	Particulate Rate		
			g/hr	g/kg fuel	g/kW/hr
1450/2	1	18.05	8.36	1.82	1.67
	2	17.21	8.01	1.74	1.60
	Avg	17.63	8.19	1.78	1.64
1450/25	1	21.67	11.74	0.90	0.23
	2	22.47	12.15	0.93	0.24
	Avg	22.07	11.95	0.92	0.24
1450/50	1	30.85	20.63	0.90	0.20
	2	25.19	16.88	0.73	0.16
	Avg	28.02	18.76	0.82	0.18
1450/75	1	50.82	43.59	1.27	0.27
	2	64.92	54.71	1.60	0.35
	Avg	57.87	49.15	1.44	0.31
1450/100	1	61.29	64.68	1.39	0.30
	2	61.23	69.87	1.51	0.33
	Avg	61.26	67.27	1.45	0.32
Idle	1	28.96	5.50	4.58	----
	2	38.13	7.23	6.03	----
	Avg	33.55	6.37	5.30	----
1900/100	1	37.29	51.10	0.92	0.22
	2	39.22	52.65	0.95	0.22
	Avg	38.26	51.88	0.94	0.22
1900/75	1	47.00	55.77	1.36	0.31
	2	47.69	56.29	1.37	0.31
	Avg	47.35	56.03	1.37	0.31
1900/50	1	36.99	35.49	1.25	0.30
	2	33.12	31.94	1.12	0.27
	Avg	35.05	33.72	1.19	0.29
1900/25	1	26.28	20.10	1.20	0.34
	2	21.27	16.22	0.97	0.28
	Avg	23.77	18.16	1.09	0.31
1900/2	1	32.19	20.21	2.89	6.12
	2	29.06	18.30	2.61	4.82
	Avg	30.63	19.25	2.75	5.47

TABLE A-11. SUMMARY OF EXHAUST $SO_4^=$ FROM MACK ETAY(B) 673A + APE, WITHOUT WATER
(Based on 47 mm Fluoropore Filters)

Engine rpm/% load	Run	Concentration µg/m³	Sulfate Rate			% Sulfur Recov.
			mg/hr	mg/kg fuel	mg/kW/hr	
1450/2	1	640.7	311.1	70.7	62.2	0.98
	2	454.9	216.0	48.0	67.5	0.67
	Avg	547.8	263.6	59.4	64.9	0.83
1450/25	1	3545.5	1924.9	149.2	37.4	2.07
	2	2786.5	1475.3	113.5	30.1	1.57
	Avg	3166.0	1700.1	131.4	33.8	1.82
1450/50	1	5616.4	3773.1	164.8	36.7	2.28
	2	6637.5	4419.7	192.2	42.9	2.66
	Avg	6127.0	4096.4	178.5	39.8	2.47
1450/75	1	7322.1	6260.1	183.6	40.1	2.54
	2	7040.7	5960.0	174.8	37.9	2.42
	Avg	7181.4	6110.1	179.2	39.0	2.48
1450/100	1	7949.1	8273.4	178.3	39.1	2.47
	2	7566.0	7864.0	169.5	37.3	2.35
	Avg	7757.6	8068.7	173.9	38.2	2.41
Idle	1	1284.5	244.7	222.5	----	3.08
	2	1647.8	309.9	281.7	----	3.90
	Avg	1466.2	277.3	252.1	----	3.49
1900/100	1	6684.8	9166.8	164.6	39.8	2.28
	2	7266.0	9857.0	177.0	42.5	2.45
	Avg	6975.4	9511.9	170.8	41.2	2.37
1900/75	1	6114.6	7336.6	179.8	42.6	2.49
	2	6574.5	7835.9	192.1	44.8	2.66
	Avg	6344.6	7586.3	186.0	43.7	2.58
1900/50	1	5751.6	5651.5	198.3	49.3	2.75
	2	5894.9	5784.9	203.0	50.5	2.81
	Avg	5823.3	5718.2	200.7	49.9	2.78
1900/25	1	3109.8	2393.2	142.5	41.9	1.98
	2	3442.6	2656.0	158.1	47.7	2.19
	Avg	3276.2	2524.6	150.3	44.8	2.09
1900/2	1	1170.0	736.2	103.7	141.6	1.44
	2	1045.9	663.3	93.4	127.6	1.29
	Avg	1108.0	699.8	98.6	134.6	1.37

TABLE A-12. SUMMARY OF EXHAUST $SO_4^=$ FROM MACK ETAY(B) 673A + APE, WITH WATER (Based on 47 mm Fluoropore Filters)

Engine rpm/% load	Run	Concentration µg/m³	Sulfate Rate			% Sulfur Recov.
			mg/hr	mg/kg fuel	mg/kW-hr	
1450/2	1	673.0	311.6	67.7	62.3	0.94
	2	702.5	326.9	71.1	65.4	0.99
	Avg	687.8	319.3	69.4	63.9	0.97
1450/25	1	4013.6	2174.1	167.2	42.6	2.32
	2	3429.3	1854.0	142.6	35.8	1.98
	Avg	3721.5	2014.0	154.9	39.2	2.15
1450/50	1	5867.3	3923.5	170.6	37.2	2.36
	2	6892.4	4578.4	199.1	43.7	2.76
	Avg	6379.9	4251.0	184.9	40.5	2.56
1450/75	1	5436.0	4662.6	136.3	29.4	1.89
	2	9046.7	7623.4	222.9	48.2	3.09
	Avg	7241.4	6143.0	179.6	38.8	2.49
1450/100	1	5064.9	5344.9	115.2	25.0	1.60
	2	5087.4	5805.5	125.1	27.1	1.73
	Avg	5076.2	5575.2	120.2	26.1	1.67
Idle	1	2052.3	389.9	324.9	----	4.50
	2	2267.1	430.1	358.4	----	4.97
	Avg	2159.7	410.0	341.7	----	4.74
1900/100	1	6568.8	9002.8	161.6	38.0	2.24
	2	5782.3	7763.1	139.4	32.9	1.93
	Avg	6175.6	8383.0	150.5	35.5	2.09
1900/75	1	6378.2	7529.0	183.6	41.9	2.54
	2	7318.0	8458.4	207.3	48.4	2.87
	Avg	6848.1	7993.7	195.5	45.2	2.71
1900/50	1	6210.0	5958.3	209.8	50.5	2.91
	2	5530.1	5333.2	187.8	45.2	2.60
	Avg	5870.1	5645.8	198.8	47.9	2.76
1900/25	1	3689.3	2821.0	167.9	47.8	2.23
	2	3432.6	2617.7	156.7	44.4	2.17
	Avg	3561.0	2719.4	162.3	46.1	2.25
1900/2	1	1532.7	946.6	137.8	253.8	1.91
	2	1761.4	1123.0	160.4	224.6	2.22
	Avg	1647.1	1043.8	149.1	239.2	2.07

TABLE A-13. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES MACK ETAY(B) 673A WITH APE PUMP, WITHOUT WATER, Run 1 (13-Mode FTP Weighting Factors)

						Weighted			
Engine rpm % Load	Power kW	Fuel kg/hr	Particulate g/hr	$SO_4^=$ mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^=$ mg/hr
Idle	---	1.1	2.26	244.7	0.067	---	0.07	0.15	16.40
1450/2	5.0	4.4	7.59	311.1	0.08	0.40	0.35	0.61	24.89
1450/25	51.5	12.9	16.27	1924.9	0.08	4.12	1.03	1.30	153.99
1450/50	102.8	22.9	43.42	3773.1	0.08	8.22	1.83	3.47	301.85
1450/75	156.2	34.1	115.83	6260.1	0.08	12.50	2.73	9.27	500.81
1450/100	216.0	46.4	226.48	8273.4	0.08	17.28	3.71	18.12	661.87
Idle	---	1.1	2.26	244.7	0.067	---	0.07	0.15	16.40
1900/100	230.5	55.7	135.00	9166.8	0.08	18.44	4.46	10.80	733.34
1900/75	172.3	40.8	92.15	7336.6	0.08	13.78	3.26	7.37	586.93
1900/50	114.6	28.5	74.52	5651.5	0.08	9.17	2.28	5.96	452.12
1900/25	57.1	16.8	39.24	2393.2	0.08	4.57	1.34	3.14	191.46
1900/2	5.2	7.1	13.81	736.2	0.08	0.42	0.57	1.11	58.90
Idle	---	1.1	2.26	244.7	0.067	---	0.07	0.15	16.40
						88.90	21.77	61.60	3715.36

Brake Specific Particulate,	g/kW-hr	0.693
Fuel Specific Particulate,	g/kg fuel	2.830
Brake Specific $SO_4^=$,	mg/kW/hr	41.79
Fuel Specific $SO_4^=$,	mg/kg fuel	170.66

TABLE A-14. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES
MACK ETAY(B) 673A WITH APE PUMP, WITHOUT WATER
Run 2 (13-mode FTP Weighting Factors)

						Weighted			
Engine rpm % Load	Power kW	Fuel kg/hr	Particulate g/hr	$SO_4^=$ mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^=$ mg/hr
Idle	---	1.1	2.08	309.9	0.067	---	0.07	0.14	20.76
1450/2	5.0	4.4	6.88	216.0	0.08	0.40	0.35	0.55	17.28
1450/25	50.5	12.8	17.40	1475.3	0.08	4.04	1.02	1.39	118.02
1450/50	103.1	23.0	46.18	4419.7	0.08	8.25	1.84	3.69	353.58
1450/75	157.2	34.1	111.15	5960.0	0.08	12.58	2.73	8.89	476.80
1450/100	214.6	46.4	198.46	7864.0	0.08	17.17	3.71	15.88	629.12
Idle	---	1.1	2.08	309.9	0.067	---	0.07	0.14	20.76
1900/100	231.7	55.7	131.67	9857.0	0.08	18.54	4.46	10.53	788.56
1900/75	175.0	40.8	96.21	7835.9	0.08	14.00	3.26	7.70	626.87
1900/50	114.6	28.5	78.70	5784.9	0.08	9.17	2.28	6.30	462.79
1900/25	55.7	16.7	48.02	2656.0	0.08	4.46	1.34	3.84	212.48
1900/2	5.2	7.1	13.38	663.3	0.08	0.42	0.57	1.07	53.06
Idle	---	1.1	2.08	309.9	0.067	---	0.07	0.14	20.76
						89.03	21.77	60.26	3800.84

Brake Specific Particulate,	g/kW-hr	0.677
Fuel Specific Particulate,	g/kg fuel	2.768
Brake Specific $SO_4^=$,	mg/kW-hr	42.69
Fuel Specific $SO_4^=$,	mg/kg fuel	174.59

TABLE A-15. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES MACK ETAY(B) 673A WITH APE PUMP, WITH WATER, Run 1 (13-Mode FTP Weighting Factors)

						Weighted			
Engine rpm % Load	Power kW	Fuel kg/hr	Particulate g/hr	$SO_4^=$ mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^=$ mg/hr
Idle	---	1.2	5.50	389.9	0.067	---	0.08	0.37	26.12
1450/2	5.0	4.6	8.36	311.6	0.08	0.40	0.37	0.67	24.93
1450/25	51.0	13.0	11.74	2174.1	0.08	4.08	1.04	0.94	173.93
1450/50	105.5	23.0	20.63	3923.5	0.08	8.44	1.84	1.65	313.88
1450/75	158.6	43.2	43.59	4662.6	0.08	12.69	2.74	3.49	373.01
1450/100	214.1	46.4	64.68	5344.9	0.08	17.13	3.71	5.17	427.59
Idle	---	1.2	5.50	389.9	0.067	---	0.08	0.37	26.12
1900/100	236.9	55.7	51.10	9002.8	0.08	18.95	4.46	4.09	720.22
1900/75	179.2	40.9	55.77	7529.0	0.08	14.34	3.27	4.46	602.32
1900/50	118.1	28.4	35.49	5958.3	0.08	9.45	2.27	2.84	476.66
1900/25	59.0	16.8	20.10	2821.0	0.08	4.72	1.34	1.61	225.68
1900/2	3.3	7.0	20.21	946.6	0.08	0.26	0.56	1.62	77.17
Idle	---	1.2	5.50	389.9	0.067	---	0.08	0.37	26.12
						90.46	21.84	27.65	3493.75

Brake Specific Particulate,	g/kW-hr	0.306
Fuel Specific Particulate,	g/kg fuel	1.266
Brake Specific $SO_4^=$,	mg/kW/hr	38.62
Fuel Specific $SO_4^=$,	mg/kg fuel	159.97

TABLE A-16. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES
MACK ETAY(B) 673A WITH APE PUMP, WITH WATER,
Run 2 (13-Mode FTP Weighting Factors)

						Weighted			
Engine rpm % Load	Power kW	Fuel kg/hr	Particulate g/hr	$SO_4^=$ mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^=$ mg/hr
Idle	---	1.2	7.23	430.1	0.067	---	0.08	0.48	28.82
1450/2	5.0	4.6	8.01	326.9	0.08	0.40	0.37	0.64	26.15
1450/25	51.7	13.0	12.15	1854.0	0.08	4.14	1.04	0.97	148.32
1450/50	106.0	23.0	16.88	4578.4	0.08	8.48	1.84	1.35	366.27
1450/75	158.3	34.2	54.71	7623.4	0.08	12.66	2.74	4.38	609.87
1450/100	213.9	46.4	69.87	5805.5	0.08	17.11	3.71	5.59	464.44
Idle	---	1.2	7.23	430.1	0.067	---	0.08	0.48	28.82
1900/100	236.1	55.7	52.65	7763.1	0.08	18.89	4.46	4.21	621.05
1900/75	179.4	41.0	56.29	8458.4	0.08	14.35	3.28	4.50	676.67
1900/50	117.9	28.5	31.94	5333.2	0.08	9.43	2.28	2.56	426.66
1900/25	58.8	16.7	16.22	2617.7	0.08	4.70	1.34	1.30	209.42
1900/2	3.8	7.0	18.30	1123.0	0.08	0.30	0.56	1.46	89.84
Idle	---	1.2	7.23	430.1	0.067	---	0.08	0.48	28.82
						90.46	21.86	28.40	3725.15

Brake Specific Particulate, g/kW-hr	0.314
Fuel Specific Particulate, g/kg fuel	1.299
Brake Specific $SO_4^=$, mg/kW/hr	41.18
Fuel Specific $SO_4^=$, mg/kg fuel	170.41

TABLE A-17. PERCENT PER STAGE OF TOTAL PARTICULATE COLLECTED BY ANDERSON IMPACTOR FOR MACK ETAY(B)673A WITH APE PUMP, WITH AND WITHOUT WATER ADDITION

Stage No.	ECD, micron,	1450 rpm		Idle	1900 rpm	
		2%	50%		100%	50%
			Without Water			
1	10.9	0.25	0.07	0.48	0.73	1.3
2	6.8	0.41	0.70	3.9	0.34	0.54
3	4.6	0.57	0.33	3.7	0.95	2.0
4	3.2	1.1	0.56	2.3	1.4	1.2
5	2.0	1.1	0.60	0.36	2.5	2.0
6	1.03	2.4	1.7	1.1	3.7	2.6
7	0.63	1.2	2.5	5.0	6.0	2.4
8	0.42	2.7	2.4	2.2	7.0	3.2
Filter	<0.42	90.2	91.2	81.0	77.4	84.7
			With Water			
1	10.9	0.74	0.77	0.36	1.1	0.39
2	6.8	1.2	1.2	0.26	1.7	0.43
3	4.6	0.34	2.8	0.08	1.3	0.59
4	3.2	0.20	2.2	0.48	1.9	0.67
5	2.0	0.74	6.4	0.58	3.4	1.1
6	1.03	2.0	2.1	0.68	3.6	1.5
7	0.63	3.6	1.4	0.72	3.4	2.2
8	0.42	1.5	2.1	0.87	3.1	3.0
Filter	<0.42	89.7	81.0	96.0	80.6	90.2

TABLE A-18. BRAKE AND FUEL SPECIFIC BaP RATE - 7-MODE CYCLE
MACK ETAY(B) 673A, WITHOUT WATER
(Based on 20 x 20 inch Pallflex Media)

										W.F. Derived from 13-Mode FTP				
Mode	Engine rpm	Engine Load, %	Power kW	Fuel kg/hr	BaP μg/hr	Part. g/hr	Org. Sol., %	SOF g/hr	Wgt. Fact	Power kW	Fuel kg/hr	Part. g/hr	BaP μg/hr	SOF g/hr
1	1450	2	5.0	4.4	34.52	7.24	81.6	5.91	0.12	0.60	0.53	0.87	4.14	0.71
2	1450	50	103.0	23.0	13.73	44.8	10.8	4.84	0.16	16.48	3.68	7.17	2.20	0.77
3	1450	100	215.3	46.4	21.19	212.	6.1	12.9	0.12	25.84	5.57	25.4	2.54	1.55
4	Idle	-	-	1.1	6.79	2.17	78.0	1.69	0.20	-	0.22	0.43	1.36	0.34
5	1900	100	231.1	55.7	BMD	133.	6.0	7.98	0.12	27.73	6.68	16.0	-	0.96
6	1900	50	114.6	28.5	BMD	76.6	15.3	11.7	0.16	18.34	4.56	12.3	-	1.87
7	1900	2	5.2	7.1	48.86	13.6	74.9	10.2	0.12	0.62	0.85	1.63	5.86	1.22
										89.61	22.09	63.8	16.10	7.42

EMD - Below Minimum Detection Limit

7-Mode Composite	
Brake Specific Part., g/kW-hr	0.712
Fuel Specific Part., g/kg fuel	2.89
Brake Specific BaP, μg/kW-hr	0.180
Fuel Specific BaP, μg/kg fuel	0.729
Brake Specific SOF, g/kW-hr	0.083
Fuel Specific SOF, g/kg fuel	0.336
Organic Solubles, %	11.7

TABLE A-19. BRAKE AND FUEL SPECIFIC BaP RATE - 7-MODE CYCLE
MACK ETAY(B) 673A RUN WITH WATER ADDITION
(Based on 20 x 20 inch Pallflex Media)

										W.F. Derived from 13-Mode FTP				
Mode	Engine rpm	Engine Load, %	Power kW	Fuel kg/hr	BaP µg/hr	Part. g/hr	Org Sol., %	SOF g/hr	Wgt. Fact	Power kW	Fuel kg/hr	Part. g/hr	BaP µg/hr	SOF g/hr
1	1450	2	5.0	4.6	29.66	8.19	85.0	6.96	0.12	0.60	0.55	0.98	3.56	0.84
2	1450	50	105.8	23.0	18.57	18.8	21.1	3.97	0.16	16.93	3.68	3.01	2.97	0.64
3	1450	100	214.0	46.4	BMD	67.3	6.9	4.64	0.12	25.68	5.57	8.08	BMD	0.56
4	Idle	-	-	1.2	30.56	6.37	95.6	6.09	0.20	-	0.24	1.27	6.11	1.22
5	1900	100	236.5	55.7	2.66	51.9	8.3	4.31	0.12	28.38	6.68	6.23	0.32	0.52
6	1900	50	118.0	28.5	20.37	33.7	31.0	10.4	0.16	18.88	4.56	5.39	3.26	1.66
7	1900	2	3.6	7.0	35.17	19.3	84.6	16.3	0.12	0.43	0.84	2.32	4.22	1.96
										90.90	22.12	27.3	20.44	7.40

BMD - Below Minimum Detection Limit

7-Mode Composite	
Brake Specific Part., g/kW-hr	0.300
Fuel Specific Part., g/kg fuel	1.23
Brake Specific BaP, µg/kW-hr	0.225
Fuel Specific BaP, µg/kg fuel	0.924
Brake Specific SOF, g/kW-hr	0.081
Fuel Specific SOF, g/kg fuel	0.362
Organic Solubles, %	27.0

APPENDIX B

TEST RESULTS FROM THE CUMMINS VTB-903 IN BASELINE AND MALADJUSTED CONFIGURATIONS

TABLE B-1. ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

ENGINE DESCRIPTION

Engine: 1979 Cummins VTB-903 Coach
Rated Power: 278 @ 2100
Maximum Torque: @ 1500
Comments: No. 2 Fuel

ENGINE DATA

	Mfg. Spec.	Measured
Max. Engine Torque, Ft-Lb @ RPM	@ 1500	766 @ 1600
Max. Engine Power, Hp @ RPM	278 @ 2100	270 @ 2100
Cylinder Compression, psi min.-max. (avg.)	-	-
Idle RPM	625	650

Comments: Rated Power and Maximum Torque are not applicable

POWER MAPPING (TQ in ft-lb) @ Temp. - 78 Baro. - 29.69

RPM	TQ	RPM	TQ	RPM	TQ	RPM	TQ	RPM	TQ
-	-	1100	475	2100	676	3100		4100	
-	-	1200	519	2200	372	3200		4200	
-	-	1300	584	2300	180	3300		4300	
400	285	1400	687	2400	0	3400		4400	
500	355	1500	764	2500		3500		4500	
600	428	1600	766	2600		3600		4600	
700	435	1700	758	2700		3700		4700	
800	438	1800	747	2800		3800		4800	
900	438	1900	729	2900		3900		4900	
1000	464	2000	707	3000		4000		5000	

TABLE B-2. ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

DIESEL TRANSIENT CYCLE

	Test D11-1			Test D11-2			
	Cold	Hot	Composite	Cold	Hot	Composite	Average
HC, g/kW-hr	3.18	1.65	1.87	2.87	1.53	1.72	1.79
CO, g/kW-hr	2.25	1.82	1.88	2.35	1.72	1.81	1.87
CO_2, g/kW-hr	895.	838.	846.	874.	838.	843.	844.
NOX, g/kW-hr	7.77	8.60	8.48	7.72	8.60	8.47	7.83
SFC, kg/kW-hr	0.287	0.267	0.270	0.280	0.267	0.269	0.269
WORK, kW-hr	12.17	12.17	12.17	12.28	12.31	12.31	12.21
POWER, kW	36.51	26.51	36.51	36.84	26.93	36.92	36.62
Particulate, g/kW-hr	0.60	0.46	0.48	0.67	0.49	0.52	0.51
Filter Eff. %	87.	91.	90.	88.	91.	91.	90.

13-MODE

	Test	Test	Average
HC, g/kW-hr	0.944	0.969	9.957
CO, g/kW-hr	2.412	1.988	2.200
CO_2, g/kW-hr			
NOX, g/kW-hr	9.224	9.352	9.288
SFC, kg/kW-hr	0.254	0.254	0.254
POWER, kW	72	72	72

IDLE

	Test	Test	Average
RPM			
HC, ppmC			
CO, %		NA	
CO_2, %			
Fuel, kg/hr			

DIESEL TRANSIENT CYCLE AVERAGE VALUES

HC,	g/kW-hr (g/hp-hr)	1.79	(1.33)
CO,	g/kW-hr (g/hp-hr)	1.87	(1.39)
NOX,	g/kW-hr (g/hp-hr)	7.83	(5.84)
Particulate,	g/kW-hr (g/hp-hr)	0.51	(0.38)
SFC,	kg/kW-hr(lb/hp-hr)	0.269	(0.442)
WORK,	kW-hr (hp-hr)	12.21	(16.37)

	g/kg Fuel	g/km[a]
HC	6.65	2.12
CO	6.95	2.22
NOX	29.11	9.28
Particulate	1.90	0.60
FUEL CONS.		319.

[a] Using a composite value of 10.30 km for the Transient Cycle.

TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

DIESEL TRANSIENT CYCLE

	Test D11-3			Test			
	Cold	Hot	Composite	Cold	Hot	Composite	Average
HC, g/kW-hr	2.82	1.62	1.79				
CO, g/kW-hr	2.31	1.86	1.92				
CO_2, g/kW-hr	883.	837.	844				
NOX, g/kW-hr	6.22	6.61	6.55				
SFC, kg/kW-hr	0.282	0.266	0.268				
WORK, kW-hr	12.16	12.14	12.14				
POWER, kW	36.48	36.42	36.43				
Particulate, g/kW-hr	0.67	0.52	0.54				
Filter Eff. %	87	91	90				

13-MODE

	Test	Test	Average
HC, g/kW-hr			
CO, g/kW-hr			
CO_2, g/kW-hr			
NOX, g/kW-hr			
SFC, kg/kW-hr			
POWER, kW			

IDLE

	Test	Test	Average
RPM			
HC, ppmC			
CO, %			
CO_2, %			
Fuel, kg/hr			

DIESEL TRANSIENT CYCLE AVERAGE VALUES

HC,	g/kW-hr (g/hp-hr)
CO,	g/kW-hr (g/hp-hr)
NOX,	g/kW-hr (g/hp-hr)
Particulate,	g/kW-hr (g/hp-hr)
SFC,	kg/kW-hr (lb/hp-hr)
WORK,	kW-hr (hp-hr)

	g/kg Fuel	g/km[a]
HC		
CO		
NOX		
Particulate		
FUEL CONS.		

[a] Using a composite value of 10.30 km for the Transient Cycle.

TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

CUMMINS VTB-903
TEST D11-2
FUEL: EM-321-F
NO. 2 FUEL
PROJECT:11-5044-001
BAROMETER 29.20
DATE: 01/29/80

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED				CALCULATED GRAMS / HOUR			MODE
									HC PPM	CO PPM	CO2 PCT	NOX PPM	HC	CO	NOX	
1		IDLE / 660	0	0.0	.024	5.02	8.8	.996	332	133	1.14	50	41	33	20	1
2	2	INTER / 1500	24	3.8	.091	12.05	8.8	.499	524	173	1.51	50	183	121	57	2
3	25	INTER / 1500	258	40.5	.197	12.42	8.8	.991	150	93	3.42	168	53	65	189	3
4	50	INTER / 1500	529	83.1	.329	12.96	8.8	.986	96	80	5.52	485	36	58	566	4
5	75	INTER / 1500	773	121.4	.431	13.44	8.8	.983	78	133	7.25	915	30	96	1062	5
6	100	INTER / 1500	1031	161.9	.586	14.02	8.8	.979	56	653	9.40	1532	23	493	1848	6
7		IDLE / 660	0	0.0	.022	5.04	8.8	.996	352	146	1.10	50	41	34	19	7
8	100	RATED / 2100	895	196.9	.748	21.62	9.0	.983	120	164	7.40	1266	77	202	2495	8
9	75	RATED / 2100	604	132.7	.519	20.05	9.0	.985	85	119	5.70	630	49	132	1121	9
10	50	RATED / 2100	448	98.4	.435	19.39	9.0	.986	95	119	4.80	260	54	131	461	10
11	25	RATED / 2100	156	34.3	.252	17.90	9.3	.986	152	146	2.94	130	80	152	217	11
12	2	RATED / 2100	11	2.4	.178	17.43	9.3	.987	300	186	1.97	70	161	200	121	12
13		IDLE / 660	0	0.0	.023	4.94	8.8	.981	348	173	1.10	50	42	42	19	13

MODE	CALCULATED GRAMS/KG-FUEL			CALCULATED GRAMS/KW-HR			F/A DRY MEAS	F/A STOICH	'PHI'	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
	HC	CO	NOX	HC	CO	NOX										
1	28.32	22.81	13.93	R	R	R	.0049	.0695	.070	.988	.0056	15.4	.990	R	.067	1
2	33.67	22.29	10.45	47.77	31.62	14.83	.0076	.0695	.109	.985	.0075	-1.7	1.006	1.411	.080	2
3	4.49	5.50	16.05	1.31	1.60	4.67	.0160	.0695	.230	.969	.0161	1.0	1.007	.289	.080	3
4	1.82	2.94	28.69	.43	.70	6.81	.0256	.0695	.368	.952	.0257	.3	1.010	.235	.080	4
5	1.14	3.72	41.10	.24	.79	8.75	.0323	.0695	.465	.939	.0335	3.6	1.013	.210	.080	5
6	.64	14.04	52.59	.14	3.05	11.42	.0422	.0695	.607	.922	.0432	2.5	1.018	.213	.080	6
7	30.44	25.84	14.38	R	R	R	.0044	.0695	.063	.988	.0054	24.1	.991	R	.067	7
8	1.72	4.49	55.63	.39	1.02	12.67	.0349	.0695	.502	.938	.0342	-2.0	1.055	.216	.080	8
9	1.56	4.29	36.05	.37	.99	8.45	.0261	.0695	.376	.951	.0265	1.6	1.047	.224	.080	9
10	2.06	5.02	17.67	.54	1.33	4.68	.0226	.0695	.325	.958	.0224	-.8	1.041	.254	.080	10
11	5.26	10.01	14.34	2.32	4.42	6.33	.0142	.0695	.205	.973	.0139	-2.1	1.034	.427	.080	11
12	15.14	18.75	11.36	67.64	83.76	50.76	.0103	.0695	.148	.981	.0095	-7.5	1.030	4.336	.080	12
13	30.57	30.56	14.14	R	R	R	.0046	.0695	.067	.988	.0054	17.7	.942	R	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- = .469 GRAM/KW-HR (.723 GRAM/BHP-HR)
BSCO ------- = 1.988 GRAM/KW-HR (1.483 GRAM/BHP-HR)
BSNOX ------ = 9.352 GRAM/KW-HR (6.977 GRAM/BHP-HR)
BSHC + BSNOX = 10.321 GRAM/KW-HR (7.699 GRAM/BHP-HR)
CORR. BSFC - = .254 KG/KW-HR (.417 LBS/BHP-HR)

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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

CUMMINS VTB-903
TEST 011-1
FUEL: EM-321-F
NO. 2 FUEL
PROJECT:11-5044-001
BAROMETER 29.17
DATE: 01/29/80

MODE	POWER	ENGINE SPEED	TORQUE OBS	POWER OBS	FUEL FLOW	AIR FLOW	INTAKE HUMID	NOX CORR	MEASURED HC	MEASURED CO	MEASURED CO2	MEASURED NOX	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
	PCT	COND / RPM	N X M	KW	KG/MIN	KG/MIN	G/KG	FACT	PPM	PPM	PCT	PPM				
1		IDLE / 660	0	0.0	.022	5.16	8.8	.967	348	173	1.07	49	41	41	18	1
2	2	INTER / 1500	24	3.8	.091	12.24	8.8	.968	528	235	1.52	51	182	163	56	2
3	25	INTER / 1500	258	40.5	.201	12.53	8.8	.970	190	153	3.45	175	50	108	195	3
4	50	INTER / 1500	529	83.1	.330	13.07	8.8	.972	92	139	5.53	490	34	101	565	4
5	75	INTER / 1500	773	121.4	.427	13.56	8.8	.973	77	199	7.34	950	29	141	1068	5
6	100	INTER / 1500	1031	161.9	.587	14.09	8.8	.976	56	774	9.37	1539	23	587	1857	6
7		IDLE / 660	0	0.0	.023	5.13	8.8	.967	344	205	1.10	51	41	49	19	7
8	100	RATED / 2100	895	196.9	.744	21.93	8.8	.974	130	156	7.44	1263	82	188	2425	8
9	75	RATED / 2100	604	132.7	.516	20.18	8.8	.972	82	133	5.73	633	46	146	1101	9
10	50	RATED / 2100	448	98.4	.430	19.43	8.8	.971	92	138	4.75	260	52	152	453	10
11	25	RATED / 2100	156	34.3	.249	18.14	8.8	.969	152	186	2.92	124	79	192	202	11
12	2	RATED / 2100	11	2.4	.177	17.63	8.8	.468	284	212	2.00	65	150	223	108	12
13		IDLE / 660	0	0.0	.021	5.06	8.8	.967	324	190	1.12	48	36	42	17	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	A/A STOICH	'PHI'	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	31.38	31.38	14.02	R	R	R	.0043	.0695	.062	.988	.0053	23.8	.989	R	.067	1
2	33.58	29.96	10.27	47.57	42.44	14.54	.0075	.0695	.107	.985	.0075	1.0	1.004	1.410	.080	2
3	4.15	8.95	16.20	1.24	2.66	4.82	.0162	.0695	.233	.969	.0163	.8	1.006	.246	.080	3
4	1.74	5.10	28.49	.42	1.22	6.79	.0255	.0695	.367	.952	.0258	1.0	1.008	.237	.060	4
5	1.11	5.50	41.69	.24	1.16	8.80	.0318	.0695	.457	.938	.0339	6.7	1.011	.209	.080	5
6	.64	16.67	52.77	.14	3.62	11.47	.0420	.0695	.604	.922	.0432	2.8	1.013	.214	.080	6
7	30.14	36.13	14.18	R	R	R	.0045	.0695	.064	.988	.0055	22.6	.990	R	.067	7
8	1.85	4.22	54.34	.42	.96	12.32	.0342	.0695	.492	.937	.0346	1.1	1.051	.216	.080	8
9	1.50	4.71	35.53	.35	1.10	8.29	.0258	.0695	.371	.951	.0267	3.3	1.041	.224	.080	9
10	2.01	5.89	17.57	.53	1.54	4.61	.0223	.0695	.321	.958	.0222	-.5	1.037	.253	.080	10
11	5.29	12.82	13.51	2.31	5.59	5.90	.0139	.0695	.200	.973	.0139	-.1	1.029	.424	.080	11
12	14.12	21.05	10.20	62.82	93.63	45.36	.0101	.0695	.146	.981	.0097	-4.6	1.026	4.336	.080	12
13	28.00	33.01	13.16	R	R	R	.0042	.0695	.061	.988	.0055	31.4	.987	R	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

```
BSHC ------- =   .944  GRAM/KW-HR    (  .704  GRAM/BHP-HR )
BSCO ------- =  2.412  GRAM/KW-HR    ( 1.799  GRAM/BHP-HR )
BSNOX ------ =  9.224  GRAM/KW-HR    ( 6.881  GRAM/BHP-HR )
BSHC + BSNOX = 10.169  GRAM/KW-HR    ( 7.586  GRAM/BHP-HR )
CORR. BSFC - =   .254   KG/KW-HR     (  .417  LBS/BHP-HR  )
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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS

1979 Cummins VTB-903 Coach

Fuel No. 2

Baseline Configuration

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                                                                                              PROJECT NO. 11-5044-001
ENGINE  NO.C 903                          TEST NO.D11-1  RUN
ENGINE  MODEL   79 CUMMINS VTB 903        DATE  2/ 1/80
ENGINE 14.8 L(903. CID) V-8               TIME 01:53                              DIESEL   EM-321-F
CVS NO.  10                                  DYNO NO.  5                             BAG CART NO.  1

BAROMETER 751.84 MM HG(29.60 IN HG)       RELATIVE HUMIDITY 49. PCT
DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)     ABSOLUTE HUMIDITY  8.3 GM/KG( 57.8 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                  2                  3                  4
  DESCRIPTION                               NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)        746.8 (29.4)       746.8 (29.4)       746.8 (29.4)       746.8 (29.4)
  BLOWER INLET P MM. H2O(IN. H2O)      650.2 (25.6)       650.2 (25.6)       650.2 (25.6)       650.2 (25.6)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                       6179.              6266.              6372.              6202.
  TIME SECONDS                             295.9              300.2              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)      296.5 (10471.)     300.6 (10618.)     305.7 (10798.)     297.6 (10510.)

  HC  SAMPLE METER/RANGE/PPM           52.9/11/  53.      73.2/11/  73.      92.3/11/  92.      40.3/11/  40.
  HC  BCKGRD METER/RANGE/PPM            9.0/ 1/   9.       9.1/ 1/   9.       9.4/ 1/   9.       9.9/ 1/  10.
  CO  SAMPLE METER/RANGE/PPM           26.8/13/  24.      24.2/13/  22.      27.7/13/  25.      15.2/13/  13.
  CO  BCKGRD METER/RANGE/PPM            1.9/13/   2.        .8/13/   1.        .8/13/   1.        .8/13/   1.
  CO2 SAMPLE METER/RANGE/PCT           21.9/ 3/  .35      27.1/ 3/  .44      59.3/ 3/ 1.05      18.1/ 3/  .29
  CO2 BCKGRD METER/RANGE/PCT            2.5/ 3/  .04       3.0/ 3/  .05       3.0/ 3/  .05       2.9/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM            6.2/13/  19.      10.2/13/  31.      33.7/13/ 101.       5.6/13/  17.
  NOX BCKGRD METER/RANGE/PPM             .8/ 2/   1.       1.1/ 2/   1.       1.1/ 2/   1.       1.1/ 2/   1.

  DILUTION FACTOR                          37.05              29.53              12.63              45.44
  HC  CONCENTRATION PPM                    44.                64.                84.                31.
  CO  CONCENTRATION PPM                    22.                20.                23.                12.
  CO2 CONCENTRATION PCT                    .32                .40               1.01                .25
  NOX CONCENTRATION PPM                   17.8               29.6              100.1               15.8

  HC  MASS GRAMS                          7.54              11.17              14.75               5.26
  CO  MASS GRAMS                          7.59               7.17               8.34               4.32
  CO2 MASS GRAMS                        1720.4             2202.1             5636.6             1341.3
  NOX MASS GRAMS                         10.07              17.02              58.55               8.49
  FUEL KG (LB)                         .554 (   1.22)   .709 (   1.56)  1.796 (   3.96)   .430 (    .95)
  KW HR (HP HR)                       1.34 (   1.79)   2.23 (   3.00)   7.35 (   9.86)   1.25 (   1.67)

  BSHC G/KW HR (G/HP HR)              5.64 (   4.21)   5.00 (   3.73)   2.01 (   1.50)   4.21 (   3.14)
  BSCO G/KW HR (G/HP HR)              5.67 (   4.23)   3.21 (   2.39)   1.13 (    .85)   3.46 (   2.58)
  BSCO2 G/KW HR (G/HP HR)          1286.79 ( 959.56) 985.67 ( 735.01) 766.54 ( 571.61) 1073.92 ( 800.82)
  BSNOX G/KW HR (G/HP HR)             7.53 (   5.62)   7.62 (   5.68)   7.96 (   5.94)   7.20 (   5.37)
  BSFC KG/KW HR (LB/HP HR)            .414 (   .681)   .317 (   .522)   .244 (   .401)   .344 (   .566)

TOTAL TEST RESULTS 4 BAGS                         PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)        12.17 ( 16.32)       90MM FILTER
   BSHC   G/KW HR (G/HP HR)   3.18 (  2.37)            SAMPLE FLOW      SCM(SCF)                      .957 ( 33.80)
   BSCO   G/KW HR (G/HP HR)   2.25 (  1.68)            MULTIPLIER FOR   G/TEST                       1.254
   BSCO2  G/KW HR (G/HP HR)   895. (  668.)            MULTIPLIER FOR   G/KW HR (G/HP HR)            .1031 ( .0768)
   BSNOX  G/KW HR (G/HP HR)   7.77 (  5.80)            MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)        .3596 ( .1631)
   BSFC  KG/KW HR (LB/HP HR)  .287 (  .471)
                                                  20 X 20 FILTERS
                                                       SAMPLE FLOW      SCM(SCF)                     83.68 (2955.7)
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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

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                                                                                       PROJECT NO. 11-5044-001
ENGINE  NO.C 903                          TEST NO.D11-1  RUN
ENGINE  MODEL   79 CUMMINS VTB903         DATE  2/ 1/80
ENGINE 14.8 L(903. CID) V-8               TIME 02:40                       DIESEL   EM-321-F
CVS NO.  10                                DYNO NO.  5                      BAG CART NO.  1

BAROMETER 751.84 MM HG(29.60 IN HG)       RELATIVE HUMIDITY 49. PCT
DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)     ABSOLUTE HUMIDITY  8.3 GM/KG( 57.8 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                     1                  2                  3                  4
  DESCRIPTION                                   NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)            746.8 (29.4)       746.8 (29.4)       746.8 (29.4)       746.8 (29.4)
  BLOWER INLET P MM. H2O(IN. H2O)          650.2 (25.6)       650.2 (25.6)       650.2 (25.6)       650.2 (25.6)
  BLOWER INLET TEMP. DEG. C(DEG. F)         48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                           6181.              6264.              6372.              6201.
  TIME SECONDS                                 296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)          296.6 (10477.)     300.6 (10618.)     305.8 (10800.)     297.6 (10511.)

  HC  SAMPLE METER/RANGE/PPM               6.7/22/  33.       9.2/22/  46.       8.2/22/  41.       7.2/22/  36.
  HC  BCKGRD METER/RANGE/PPM               9.0/ 1/   9.       9.9/ 1/  10.      11.0/ 1/  11.      12.0/ 1/  12.
  CO  SAMPLE METER/RANGE/PPM              16.9/13/  15.      20.1/13/  18.      23.6/13/  21.      16.2/13/  14.
  CO  BCKGRD METER/RANGE/PPM               1.1/13/   1.        .9/13/   1.       1.0/13/   1.       1.0/13/   1.
  CO2 SAMPLE METER/RANGE/PCT              18.1/ 3/  .29      25.6/ 3/  .42      58.4/ 3/ 1.03      17.4/ 3/  .29
  CO2 BCKGRD METER/RANGE/PCT               3.2/ 3/  .05       3.1/ 3/  .05       3.1/ 3/  .05       3.0/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM               5.5/13/  17.      11.2/13/  34.      38.2/13/ 115.       6.3/13/  19.
  NOX BCKGRD METER/RANGE/PPM                .8/ 2/   1.        .8/ 2/   1.        .3/ 3/   1.        .9/ 2/   1.

  DILUTION FACTOR                             45.53              31.58              12.92              46.02
  HC  CONCENTRATION PPM                       25.                36.                31.                24.
  CO  CONCENTRATION PPM                       14.                17.                20.                13.
  CO2 CONCENTRATION PCT                        .24                .37                .99                .24
  NOX CONCENTRATION PPM                       15.9               32.9              113.8               17.9

  HC  MASS GRAMS                               4.20               6.29               5.45               4.18
  CO  MASS GRAMS                               4.74               5.84               6.97               4.56
  CO2 MASS GRAMS                            1312.5             2048.5             5529.8             1314.8
  NOX MASS GRAMS                               9.00              18.93              66.54              10.18
  FUEL KG (LB)                              .420 (    .93)    .655 (   1.44)    1.752 (   3.86)     .421 (    .93)
  KW HR (HP HR)                             1.28 (   1.72)    2.29 (   3.07)     7.34 (   9.84)     1.27 (   1.70)

  BSHC G/KW HR (G/HP HR)                    3.27 (   2.44)    2.75 (   2.05)      .74 (    .55)     3.30 (   2.46)
  BSCO G/KW HR (G/HP HR)                    3.69 (   2.75)    2.56 (   1.91)      .95 (    .71)     3.60 (   2.69)
  BSCO2 G/KW HR (G/HP HR)                1022.06 ( 762.15)  895.77 ( 667.97)   753.83 ( 562.13)  1038.11 ( 774.12)
  BSNOX G/KW HR (G/HP HR)                   7.01 (   5.22)    8.28 (   6.17)     9.07 (   6.76)     8.04 (   5.99)
  BSFC KG/KW HR (LB/HP HR)                  .327 (   .538)    .286 (   .471)     .239 (   .393)     .332 (   .546)

TOTAL TEST RESULTS 4 BAGS                          PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)           12.17 ( 16.32)         90MM FILTER
   BSHC   G/KW HR (G/HP HR)      1.65 (  1.23)            SAMPLE FLOW      SCM(SCF)                  1.013 ( 35.78)
   BSCO   G/KW HR (G/HP HR)      1.82 (  1.35)            MULTIPLIER FOR   G/TEST                    1.185
   BSCO2  G/KW HR (G/HP HR)      838. (  625.)            MULTIPLIER FOR   G/KW HR (G/HP HR)         .0973 ( .0726)
   BSNOX  G/KW HR (G/HP HR)      8.60 (  6.41)            MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)     .3648 ( .1655)
   BSFC   KG/KW HR (LB/HP HR)    .267 (  .439)
                                                       20 X 20 FILTERS
                                                          SAMPLE FLOW     SCM(SCF)                  83.44 (2964.6)
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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

PROJECT NO. 11-5044-001

ENGINE NO.
ENGINE MODEL 79 CUMMINS VTB903
ENGINE 14.8 L(903. CID) V-8
CVS NO. 10

TEST NO.D11-2 RUN
DATE 2/ 4/80
TIME 12:58
DYNO NO. 5

DIESEL EM-321-F
BAG CART NO. 1

BAROMETER 745.24 MM HG(29.34 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY 43. PCT
ABSOLUTE HUMIDITY 8.6 GM/KG(60.5 GRAINS/LB)
NOX HUMIDITY C.F. 1.0000

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
BLOWER DIF P MM. H2O(IN. H2O)	746.8 (29.4)	746.8 (29.4)	746.8 (29.4)	746.8 (29.4)
BLOWER INLET P MM. H2O(IN. H2O)	650.2 (25.6)	650.2 (25.6)	650.2 (25.6)	650.2 (25.6)
BLOWER INLET TEMP. DEG. C(DEG. F)	48.9 (120.0)	48.9 (120.0)	48.9 (120.0)	48.9 (120.0)
BLOWER REVOLUTIONS	6183.	6266.	6372.	6202.
TIME SECONDS	296.0	300.0	305.0	296.9
TOTAL FLOW STD. CU. METRES(SCF)	293.9 (10382.)	297.9 (10521.)	302.9 (10699.)	294.8 (10414.)
HC SAMPLE METER/RANGE/PPM	10.5/22/ 52.	13.8/22/ 69.	17.6/22/ 88.	8.1/22/ 40.
HC BCKGRD METER/RANGE/PPM	9.9/ 1/ 10.	13.0/ 1/ 13.	12.1/ 1/ 12.	12.2/ 1/ 12.
CO SAMPLE METER/RANGE/PPM	28.7/13/ 26.	26.4/13/ 24.	30.9/13/ 28.	17.7/13/ 16.
CO BCKGRD METER/RANGE/PPM	2.5/13/ 2.	2.4/13/ 2.	2.3/13/ 2.	2.3/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	22.2/ 3/ .36	27.7/ 3/ .45	60.4/ 3/ 1.07	19.4/ 3/ .31
CO2 BCKGRD METER/RANGE/PCT	4.4/ 3/ .07	3.9/ 3/ .06	4.0/ 3/ .06	4.0/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	5.8/13/ 18.	9.7/13/ 29.	34.7/13/ 104.	5.6/13/ 17.
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1.	.7/ 2/ 1.	.7/ 2/ 1.	.8/ 2/ 1.
DILUTION FACTOR	36.52	28.87	12.38	42.27
HC CONCENTRATION PPM	43.	56.	77.	29.
CO CONCENTRATION PPM	23.	21.	25.	13.
CO2 CONCENTRATION PCT	.29	.40	1.01	.25
NOX CONCENTRATION PPM	16.8	28.6	103.6	16.0
HC MASS GRAMS	7.23	9.68	13.44	4.86
CO MASS GRAMS	7.97	7.35	8.90	4.61
CO2 MASS GRAMS	1579.5	2166.4	5627.8	1358.1
NOX MASS GRAMS	9.46	16.27	60.03	9.00
FUEL KG (LB)	.509 (1.12)	.696 (1.53)	1.792 (3.95)	.435 (.96)
KW HR (HP HR)	1.37 (1.84)	2.25 (3.02)	7.39 (9.91)	1.27 (1.70)
BSHC G/KW HR (G/HP HR)	5.27 (3.93)	4.30 (3.21)	1.82 (1.36)	3.84 (2.86)
BSCO G/KW HR (G/HP HR)	5.81 (4.33)	3.27 (2.44)	1.20 (.90)	3.64 (2.72)
BSCO2 G/KW HR (G/HP HR)	1151.15 (858.41)	962.12 (717.45)	761.71 (568.01)	1072.25 (799.58)
BSNOX G/KW HR (G/HP HR)	6.90 (5.14)	7.23 (5.39)	8.13 (6.06)	7.10 (5.30)
BSFC KG/KW HR (LB/HP HR)	.371 (.610)	.309 (.508)	.243 (.399)	.344 (.565)

TOTAL TEST RESULTS 4 BAGS	
TOTAL KW HR (HP HR)	12.28 (16.47)
BSHC G/KW HR (G/HP HR)	2.87 (2.14)
BSCO G/KW HR (G/HP HR)	2.35 (1.75)
BSCO2 G/KW HR (G/HP HR)	874. (652.)
BSNOX G/KW HR (G/HP HR)	7.72 (5.76)
BSFC KG/KW HR (LB/HP HR)	.280 (.460)

PARTICULATE DATA, TOTAL FOR 4 BAGS

90MM FILTER		
SAMPLE FLOW	SCM(SCF)	.954 (33.68)
MULTIPLIER FOR	G/TEST	1.247
MULTIPLIER FOR	G/KW HR (G/HP HR)	.1016 (.0758)
MULTIPLIER FOR	G/KG FUEL (G/LB FUEL)	.3634 (.1648)

20 X 20 FILTERS		
SAMPLE FLOW	SCM(SCF)	83.49 (2948.9)

TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

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                                                                                        PROJECT NO. 11-5044-001
ENGINE  NO.                                       TEST NO.D11-2  RUN
ENGINE  MODEL    79 CUMMINS VTB903                DATE  2/ 4/80
ENGINE 14.8 L(903. CID) V-8                       TIME 01:45                     DIESEL   EM-321-F
CVS NO.  10                                        DYNO NO.  5                      BAG CART NO.  1

BAROMETER 745.24 MM HG(29.34 IN HG)               RELATIVE HUMIDITY 43. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)             ABSOLUTE HUMIDITY  8.6 GM/KG( 60.5 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                    2                    3                    4
  DESCRIPTION                               NYNF                 LANF                  LAF                 NYNF
  BLOWER DIF P MM. H2O(IN. H2O)        746.8 (29.4)         746.8 (29.4)         746.8 (29.4)         746.8 (29.4)
  BLOWER INLET P MM. H2O(IN. H2O)      650.2 (25.6)         650.2 (25.6)         650.2 (25.6)         650.2 (25.6)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)         48.9 (120.0)         48.9 (120.0)         48.9 (120.0)
  BLOWER REVOLUTIONS                       6182.                6265.                6372.                6201.
  TIME SECONDS                             296.0                300.0                305.0                296.9
  TOTAL FLOW STD. CU. METRES(SCF)      294.1 (10389.)       298.1 (10528.)       303.2 (10708.)       295.0 (10421.)

  HC  SAMPLE METER/RANGE/PPM            7.0/22/  35.         9.1/22/  46.         8.2/22/  41.         7.2/22/  36.
  HC  BCKGRD METER/RANGE/PPM           12.1/ 1/  12.        12.2/ 1/  12.        12.7/ 1/  13.        12.7/ 1/  13.
  CO  SAMPLE METER/RANGE/PPM           17.0/13/  15.        19.3/13/  17.        22.4/13/  20.        15.5/13/  14.
  CO  BCKGRD METER/RANGE/PPM            1.1/13/   1.          .9/13/   1.         1.0/13/   1.         1.1/13/   1.
  CO2 SAMPLE METER/RANGE/PCT           18.9/ 3/  .30        26.5/ 3/  .43        59.5/ 3/ 1.05        17.7/ 3/  .28
  CO2 BCKGRD METER/RANGE/PCT            3.3/ 3/  .05         3.2/ 3/  .05         3.7/ 3/  .06         3.0/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM            5.5/13/  17.        11.3/13/  34.        39.1/13/ 117.         6.1/13/  18.
  NOX BCKGRD METER/RANGE/PPM             .4/ 2/   0.          .4/ 2/   0.          .3/ 3/   1.          .4/ 2/   0.

  DILUTION FACTOR                          43.51                30.45                12.65                46.57
  HC  CONCENTRATION PPM                    23.                  34.                  29.                  23.
  CO  CONCENTRATION PPM                    14.                  16.                  19.                  12.
  CO2 CONCENTRATION PCT                    .25                  .39                 1.00                  .24
  NOX CONCENTRATION PPM                   16.2                 33.5                116.6                 17.9

  HC  MASS GRAMS                          3.90                 5.81                 5.10                 3.99
  CO  MASS GRAMS                          4.73                 5.56                 6.54                 4.29
  CO2 MASS GRAMS                        1366.2               2109.4               5556.3               1285.4
  NOX MASS GRAMS                          9.14                19.08                67.62                10.13
  FUEL KG (LB)                        .437 (    .96)     .674 (   1.48)    1.760 (   3.88)     .411 (    .91)
  KW HR (HP HR)                       1.32 (   1.77)     2.29 (   3.07)     7.42 (   9.96)     1.28 (   1.72)

  BSHC G/KW HR (G/HP HR)              2.95 (   2.20)     2.54 (   1.89)      .69 (    .51)     3.11 (   2.32)
  BSCO G/KW HR (G/HP HR)              3.59 (   2.68)     2.43 (   1.81)      .88 (    .66)     3.34 (   2.49)
  BSCO2 G/KW HR (G/HP HR)          1035.49 ( 772.17)   922.37 ( 687.81)   748.47 ( 558.13)  1000.93 ( 746.39)
  BSNOX G/KW HR (G/HP HR)             6.93 (   5.17)     8.34 (   6.22)     9.11 (   6.79)     7.89 (   5.88)
  BSFC KG/KW HR (LB/HP HR)            .331 (   .544)     .295 (   .484)     .237 (   .390)     .320 (   .527)

TOTAL TEST RESULTS 4 BAGS                                 PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          12.31 ( 16.51)            90MM FILTER
   BSHC   G/KW HR (G/HP HR)     1.53 (  1.14)                SAMPLE FLOW      SCM(SCF)                  .973 ( 34.38)
   BSCO   G/KW HR (G/HP HR)     1.72 (  1.28)                MULTIPLIER FOR  G/TEST                   1.223
   BSCO2  G/KW HR (G/HP HR)     838. (  625.)                MULTIPLIER FOR  G/KW HR (G/HP HR)        .0993 ( .0741)
   BSNOX  G/KW HR (G/HP HR)     8.60 (  6.42)                MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)    .3727 ( .1691)
   BSFC  KG/KW HR (LB/HP HR)    .267 (  .438)
                                                         20 X 20 FILTERS
                                                            SAMPLE FLOW     SCM(SCF)                 84.44 (2982.5)
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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS

1979 Cummins VTB-903 Coach

Fuel No. 2

Baseline Configuration

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                                                                                        PROJECT NO. 11-5044-001
ENGINE  NO.                                   TEST NO.D11-3  RUN
ENGINE  MODEL   79 CUMMINS VTB903             DATE  2/ 5/80
ENGINE 14.8 L(903. CID) V-8                   TIME 01:25                       DIESEL   EM-321-F
CVS NO.  10                                    DYNO NO.  5                      BAG CART NO.  1

BAROMETER 746.25 MM HG(29.38 IN HG)           RELATIVE HUMIDITY 46. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)         ABSOLUTE HUMIDITY  9.2 GM/KG( 64.7 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                         1                  2                  3                  4
  DESCRIPTION                                      NYNF               LANF               LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)               746.8 (29.4)      746.8 (29.4)      746.8 (29.4)      746.8 (29.4)
  BLOWER INLET P MM. H2O(IN. H2O)             650.2 (25.6)      650.2 (25.6)      650.2 (25.6)      650.2 (25.6)
  BLOWER INLET TEMP. DEG. C(DEG. F)            48.9 (120.0)      48.9 (120.0)      48.9 (120.0)      48.9 (120.0)
  BLOWER REVOLUTIONS                              6180.             6265.             6371.             6201.
  TIME SECONDS                                    296.0             300.0             305.0             297.0
  TOTAL FLOW STD. CU. METRES(SCF)             293.9 (10381.)    298.0 (10524.)    303.0 (10702.)    294.4 (10417.)

  HC   SAMPLE METER/RANGE/PPM                 10.1/22/  50.     12.7/22/  63.     15.9/22/  80.      7.6/22/  38.
  HC   BCKGRD METER/RANGE/PPM                  6.7/ 1/   7.      8.0/ 1/   8.      8.7/ 1/   9.      9.8/ 1/  10.
  CO   SAMPLE METER/RANGE/PPM                 26.4/13/  24.     24.6/13/  22.     28.2/13/  25.     16.7/13/  15.
  CO   BCKGRD METER/RANGE/PPM                  1.0/13/   1.       .9/13/   1.       .7/13/   1.       .7/13/   1.
  CO2  SAMPLE METER/RANGE/PCT                 21.1/ 3/  .34     26.8/ 3/  .44     58.9/ 3/ 1.04     17.4/ 3/  .28
  CO2  BCKGRD METER/RANGE/PCT                  2.5/ 3/  .04      2.4/ 3/  .04      2.3/ 3/  .04      2.5/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM                  4.3/13/  13.      8.0/13/  24.     28.2/13/  85.      4.3/13/  13.
  NOX  BCKGRD METER/RANGE/PPM                   .6/ 2/   1.       .9/ 2/   1.       .6/ 2/   1.       .7/ 2/   1.

  DILUTION FACTOR                                 38.54             29.94             12.74             47.34
  HC   CONCENTRATION PPM                           44.               56.               72.               28.
  CO   CONCENTRATION PPM                           22.               21.               24.               14.
  CO2  CONCENTRATION PCT                           .30               .40              1.01               .24
  NOX  CONCENTRATION PPM                          12.3              23.0              84.1              12.1

  HC   MASS GRAMS                                 7.43              9.56             12.50              4.84
  CO   MASS GRAMS                                 7.66              7.21              8.46              4.77
  CO2  MASS GRAMS                               1631.8            2202.5            5597.7            1248.4
  NOX  MASS GRAMS                                 6.89             13.13             48.77              6.83
  FUEL KG (LB)                               .526 (    1.16)   .707 (    1.56)  1.781 (    3.93)   .417 (     .92)
  KW HR (HP HR)                              1.34 (    1.79)   2.25 (    3.02)   7.30 (    9.79)   1.27 (    1.70)

  BSHC G/KW HR (G/HP HR)                     5.56 (    4.14)   4.25 (    3.17)   1.71 (    1.28)   3.82 (    2.85)
  BSCO G/KW HR (G/HP HR)                     5.73 (    4.27)   3.20 (    2.39)   1.16 (     .86)   3.76 (    2.81)
  BSCO2 G/KW HR (G/HP HR)                 1220.56 (  910.17) 978.15 (  729.41) 766.77 (  571.78) 1025.12 (  764.43)
  BSNOX G/KW HR (G/HP HR)                    5.16 (    3.84)   5.83 (    4.35)   6.68 (    4.98)   5.40 (    4.02)
  BSFC KG/KW HR (LB/HP HR)                   .393 (    .646)   .314 (    .517)   .244 (    .401)   .329 (    .541)

TOTAL TEST RESULTS 4 BAGS                               PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)         12.16 ( 16.30)            90MM FILTER
   BSHC   G/KW HR (G/HP HR)    2.82 (  2.11)               SAMPLE FLOW      SCM(SCF)                  .888 ( 31.35)
   BSCO   G/KW HR (G/HP HR)    2.31 (  1.72)               MULTIPLIER FOR   G/TEST                   1.340
   BSCO2  G/KW HR (G/HP HR)    883. (  658.)               MULTIPLIER FOR   G/KW HR (G/HP HR)         .1103 ( .0822)
   BSNOX  G/KW HR (G/HP HR)    6.22 (  4.64)               MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)     .3907 ( .1772)
   BSFC  KG/KW HR (LB/HP HR)   .282 (  .464)
                                                        20 X 20 FILTERS
                                                           SAMPLE FLOW      SCM(SCF)                 62.43 (2411.3)
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TABLE B-2 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Baseline Configuration

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                                                                                                   PROJECT NO. 11-5044-001
ENGINE  NO.                                           TEST NO.011-3  RUN
ENGINE  MODEL   79 CUMMINS VTB903                     DATE  2/ 5/80
ENGINE 14.8 L(903. CID) V-8                           TIME 02113                     DIESEL   EM-321-F
CVS NO.  10                                            DYNO NO.  5                     BAG CART NO.  1

BAROMETER 746.25 MM HG(29.38 IN HG)                   RELATIVE HUMIDITY 49. PCT
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)                 ABSOLUTE HUMIDITY  9.5 GM/KG( 66.7 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
   BAG NUMBER                                  1                   2                   3                   4
   DESCRIPTION                                NYNF                LANF                LAF                 NYNF
   BLOWER DIF P MM. H2O(IN. H2O)          746.8 (29.4)        746.8 (29.4)        746.8 (29.4)        746.8 (29.4)
   BLOWER INLET P MM. H2O(IN. H2O)        650.2 (25.6)        650.2 (25.6)        650.2 (25.6)        650.2 (25.6)
   BLOWER INLET TEMP. DEG. C(DEG. F)       48.9 (120.0)        48.9 (120.0)        48.9 (120.0)        48.9 (120.0)
   BLOWER REVOLUTIONS                        6182.               6265.               6371.               6202.
   TIME SECONDS                              296.0               300.0               305.0               297.0
   TOTAL FLOW STD. CU. METRES(SCF)       293.7 (10375.)      297.7 (10514.)      302.7 (10692.)      294.7 (10408.)

   HC  SAMPLE METER/RANGE/PPM             6.4/22/  32.        8.0/22/  40.        8.0/22/  40.        6.4/22/  32.
   HC  BCKGRD METER/RANGE/PPM             7.7/ 1/   8.        7.3/ 1/   7.        7.9/ 1/   8.        7.4/ 1/   8.
   CO  SAMPLE METER/RANGE/PPM            17.8/13/  16.       21.0/13/  19.       24.6/13/  22.       15.4/13/  14.
   CO  BCKGRD METER/RANGE/PPM             1.1/13/   1.         .9/13/   1.        1.1/13/   1.        1.4/13/   1.
   CO2 SAMPLE METER/RANGE/PCT            17.4/ 3/  .28       25.5/ 3/  .42       58.3/ 3/ 1.03      16.5/ 3/  .26
   CO2 BCKGRD METER/RANGE/PCT             2.3/ 3/  .04        2.2/ 3/  .03        2.3/ 3/  .04        2.3/ 3/  .04
   NOX SAMPLE METER/RANGE/PPM             4.0/13/  12.        8.9/13/  27.       30.4/13/  91.        4.4/13/  13.
   NOX BCKGRD METER/RANGE/PPM              .8/ 2/   1.         .8/ 2/   1.        1.0/ 2/   1.         .4/ 2/   1.

   DILUTION FACTOR                           47.43               31.74               12.94               50.13
   HC  CONCENTRATION PPM                      24.                 33.                 33.                 24.
   CO  CONCENTRATION PPM                      15.                 18.                 20.                 13.
   CO2 CONCENTRATION PCT                      .24                 .38                1.00                 .23
   NOX CONCENTRATION PPM                     11.3                25.9                90.2                12.4

   HC  MASS GRAMS                            4.12                5.67                5.69                4.12
   CO  MASS GRAMS                            4.96                6.07                7.19                4.32
   CO2 MASS GRAMS                          1309.3              2092.2              5526.2              1232.2
   NOX MASS GRAMS                            6.37               14.73               52.20                6.96
   FUEL KG (LB)                          .419 (    .92)    .668 (   1.47)   1.751 (   3.86)    .395 (    .87)
   KW HR (HP HR)                         1.32 (   1.77)    2.27 (   3.04)    7.30 (   9.79)    1.25 (   1.67)

   BSHC G/KW HR (G/HP HR)                3.12 (   2.33)    2.50 (   1.86)     .78 (    .58)    3.30 (   2.46)
   BSCO G/KW HR (G/HP HR)                3.76 (   2.81)    2.67 (   1.94)     .98 (    .73)    3.46 (   2.58)
   BSCO2 G/KW HR (G/HP HR)             992.41 ( 740.04)  921.96 ( 687.50)  756.97 ( 564.47)  986.56 ( 735.68)
   BSNOX G/KW HR (G/HP HR)               4.83 (   3.60)    6.49 (   4.84)    7.15 (   5.33)    5.58 (   4.16)
   BSFC KG/KW HR (LB/HP HR)              .318 (   .523)    .294 (   .484)    .240 (   .394)    .316 (   .520)

TOTAL TEST RESULTS 4 BAGS                             PARTICULATE DATA, TOTAL FOR 4 BAGS

   TOTAL KW HR (HP HR)           12.14 ( 16.28)          90MM FILTER
    BSHC    G/KW HR (G/HP HR)     1.62 (  1.20)              SAMPLE FLOW      SCM(SCF)                    .972 ( 34.34)
    BSCO    G/KW HR (G/HP HR)     1.86 (  1.38)              MULTIPLIER FOR   G/TEST                     1.223
    BSCO2   G/KW HR (G/HP HR)     837. (  624.)              MULTIPLIER FOR   G/KW HR (G/HP HR)          .1007 ( .0751)
    BSNOX   G/KW HR (G/HP HR)     6.61 (  4.93)              MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)      .3781 ( .1715)
    BSFC   KG/KW HR (LB/HP HR)    .266 (  .438)
                                                          20 X 20 FILTERS
                                                             SAMPLE FLOW     SCM(SCF)                  81.18 (2867.4)
```

1

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TABLE B-3 ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

TRANSIENT CYCLE STATISTICS

	Cold Cycle			Hot Cycle		
TEST D11-9	Speed	Torque	Power	Speed	Torque	Power
Standard Error	41.	6.%	6.%	32.	7.%	6.%
Slope	1.004	.968	1.004	1.005	.961	.998
Corr. Coef.	.9953	.9579	.9684	.9971	.9458	.9612
Intercept	13	1.2	.2	11.	1.5	.1
Points Used	1176	957	957	1176	975	975
kW-hr Dev.[c]	----	-6.9	----	----	-6.9	----
TEST D11-10						
Standard Error	44.	8.%	7.%	30.	5.%	4.%
Slope	.999	.958	.999	.997	.962	1.014
Corr. Coef.	.9946	.9325	.9530	.9981	.9120	.9413
Intercept	21.	1.8	-.1	16.	-.0	-.3
Points Used	1176	973	973	1176	1047	1047
kW-hr Dev.[c]	----	-6.2	----	----	-6.7	----

TRANSIENT CYCLE MODAL RESULTS[d]

	Cold Cycle				Hot Cycle			
Test D11-9	NYNF	LANF	LAF	NYNF	NYNF	LANF	LAF	NYNF
HC, gram	15.22	26.73	48.80	18.93	11.11	24.14	33.82	10.77
CO, gram	10.35	10.64	16.12	7.21	6.73	9.61	14.22	6.20
CO_2, gram	1651.0	2263.3	5370.4	1363.7	1384.8	2106.4	5625.0	1425.0
NOX, gram	8.71	14.56	50.08	7.84	7.53	16.28	56.83	8.56
FUEL, kg	0.535	0.738	1.732	0.448	0.446	0.686	1.796	0.458
KW-HR	1.32	2.20	7.34	1.27	1.30	2.23	7.32	1.27
TEST D11-10								
HC, gram	17.19	28.04	50.93	18.36	12.36	23.24	34.26	10.51
CO, gram	10.04	10.42	17.59	6.41	6.48	9.36	15.26	5.73
CO_2 gram	1716.3	2362.6	6170.6	1439.6	1410.7	2294.7	5962.9	1358.6
NOX, gram	9.93	15.28	54.70	8.63	8.98	17.47	62.39	9.54
FUEL, kg	0.558	0.770	1.985	0.471	0.456	0.744	1.902	0.437
KW-HR	1.39	2.22	7.34	1.27	1.30	2.23	7.34	1.27

[c] Test kW-hr minus Reference kW-hr divided by the Reference kW-hr times 100%.
[d] Barometric Pressure: Test D11-9 = 746 mm Hg Test D-11-10= 739 mm Hg.

TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

DIESEL TRANSIENT CYCLE

	Test D11-9			Test D11-10			
	Cold	Hot	Composite	Cold	Hot	Composite	Average
HC, g/kW-hr	9.05	6.59	6.94	9.38	6.62	7.01	6.98
CO, g/kW-hr	3.66	3.03	3.12	3.64	3.03	3.12	3.12
CO_2, g/kW-hr	879	870	871	957	908	915	893
NOX, g/kW-hr	6.70	7.36	7.27	7.25	8.11	7.99	7.63
SFC, kg/kW-hr	0.285	0.279	0.280	0.310	0.292	0.295	0.288
WORK, kW-hr	12.12	12.12	12.12	12.21	12.14	12.15	12.14
POWER, kW	36.36	36.36	36.36	36.63	36.42	36.45	36.40
Particulate, g/kW-hr	1.42	1.01	1.07	1.49	1.01	1.08	1.08
Filter Eff. %	88	86	86	84	89	88	87

13-MODE

	Test D11-3	Test D11-4	Average
HC, g/kW-hr	3.821	4.055	3.938
CO, g/kW-hr	4.005	3.084	3.545
CO_2, g/kW-hr			
NOX, g/kW-hr	9.134	9.360	9.247
SFC, kg/kW-hr	0.268	0.270	0.269
POWER, kW	69	69	69

IDLE

	Test	Test	Average
RPM			
HC, ppmC			
CO, %			
CO_2, %			
Fuel, kg/hr			

DIESEL TRANSIENT CYCLE AVERAGE VALUES

HC,	g/kW-hr (g/hp-hr)	6.98	(5.21)
CO,	g/kW-hr (g/hp-hr)	3.12	(2.33)
NOX,	g/kW-hr (g/hp-hr)	7.63	(5.69)
Particulate,	g/kW-hr (g/hp-hr)	1.08	(0.81)
SFC,	kg/kW-hr(1b/hp-hr)	0.288	(0.474)
WORK,	kW-hr (hp-hr)	12.14	(16.27)

	g/kg Fuel	g/km[a]
HC	24.24	8.23
CO	10.83	3.68
NOX	26.49	8.99
Particulate	3.75	1.27
FUEL CONS.		339

[a] Using a composite value of 10.30 km for the Transient Cycle.

TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

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                                 13-MODE FEDERAL CIESEL EMISSION CYCLE 1979

                      ENGINE:VTB-903 MALFUNCTION    +.CO4  AND BOOST BLEED OF 41N.HG
                      TEST NO. 1          FUEL: EM-408-F     PROJECT:11-5428-001               DATE:  3/03/80
      ----------------------------------------------------------------------------  ------------------------  ---------------------
         POWER      ENGINE     TORQUE    POWER    FUEL    AIR    INTAKE   NOX             MEASURED                CALCULATED
                    SPEED       OBS       OBS     FLOW    FLOW   HUMID    CORR     HC     CO     CO2    NOX     GRAMS / HOUR     MODE
 MODE                                                                                                                            
          PCT    COND / RPM    N X M      KW     KG/MIN  KG/MIN   G/KG    FACT     PPM    PPM    PCT    PPM     HC    CO    NOX
      ----------------------------------------------------------------------------  ------------------------  ---------------------
   1             IDLE  /  660.    0.        .0   .022    5.12    3.3     .874     456.   292.   1.14    54.     50.   64.    17.     1
   2        2    INTER / 1500.   20.       3.2   .098   12.27    3.3     .878    1240.   372.   1.92    72.    356.  214.    59.     2
   3       25    INTER / 1500.  258.      40.5   .212   12.51    3.3     .887     528.   225.   3.86   231.    176.  148.   219.     3
   4       50    INTER / 1500.  529.      83.1   .333   13.10    3.3     .895     885.   278.   6.29   605.    291.  176.   560.     4
   5       75    INTER / 1500.  773.     121.4   .438   13.38    3.3     .902    1328.   452.   8.38  1090.    438.  283.  1003.     5
   6      100    INTER / 1500.  977.     153.4   .619   13.74    3.3     .915     480.  1071.   9.83  1506.    194.  811.  1702.     6
   7             IDLE  /  660.    0.        .0   .022    5.09    3.3     .874     720.   318.   1.11    56.     79.   70.    18.     7
   8      100    RATED / 2100.  868.     190.9   .764   21.02    3.3     .906     568.   438.   8.09  1230.    340.  499.  2071.     8
   9       75    RATED / 2100.  604.     132.7   .559   19.37    3.3     .898     800.   292.   6.63   770.    421.  296.  1144.     9
  10       50    RATED / 2100.  448.      98.4   .461   18.95    3.3     .894     656.   278.   5.49   475.    341.  280.   698.    10
  11       25    RATED / 2100.  156.      34.3   .283   18.29    3.3     .885     480.   266.   3.42   166.    241.  263.   237.    11
  12        2    RATED / 2100.   19.       4.2   .200   17.41    3.3     .881     688.   319.   2.33    93.    347.  321.   135.    12
  13             IDLE  /  660.    0.        .0   .022    5.02    3.3     .875     440.   265.   1.14    65.     49.   60.    21.    13
      ------------------------------------------------------------------------------------------------------------------------------
      -------------------------------------------------   -------------------------------------------   ----------------  ------------
                           CALCULATED                     F/A     F/A            WET HC   F/A     F/A     POWER    BSFC      MODAL
 MODE          GRAMS/KG-FUEL         GRAMS/KW-HR          DRY            "PHI"   CORR             PCT     CORR     CORR      WEIGHT  MODE
           HC      CO      NOX     HC      CO      NOX    MEAS   STOICH          FACT     CALC    MEAS    FACT   KG/KW-HR    FACTOR
      -------------------------  --------------------   -------------------------------------------   ----------------  ------------
   1    37.94   48.92   12.91  ******  ******  *****   .0043   .0695    .062    .989   .0057   33.7     .997    *****      .067     1
   2    60.59   36.35   10.08  111.34   66.80  18.52   .0080   .0695    .115    .982   .0098   22.7    1.013    1.814      .080     2
   3    13.87   11.64   17.28    4.35    3.65   5.42   .0170   .0695    .244    .967   .0184    8.4    1.016     .309      .080     3
   4    14.57    8.83   28.05    3.50    2.12   6.74   .0255   .0695    .366    .947   .0297   16.5    1.020     .235      .080     4
   5    16.65   10.74   38.13    3.61    2.33   8.26   .0329   .0695    .473    .931   .0393   19.6    1.024     .211      .080     5
   6     5.22   21.83   45.82    1.26    5.29  11.09   .0452   .0695    .651    .920   .0455     .7    1.030     .235      .080     6
   7    59.93   53.31   13.40  ******  ******  *****   .0043   .0695    .062    .989   .0057   32.9    1.004    *****      .067     7
   8     7.43   10.88   45.17    1.78    2.61  10.85   .0365   .0695    .525    .934   .0376    3.1    1.068     .225      .080     8
   9    12.56    8.82   34.08    3.18    2.23   8.62   .0290   .0695    .417    .945   .0312    7.5    1.062     .238      .080     9
  10    12.31   10.13   25.25    3.46    2.85   7.10   .0244   .0695    .351    .954   .0259    6.2    1.055     .266      .080    10
  11    14.15   15.49   13.96    7.02    7.68   6.92   .0155   .0695    .224    .970   .0164    5.3    1.044     .475      .080    11
  12    28.89   26.70   11.20   83.15   76.85  32.22   .0115   .0695    .166    .979   .0114    -.9    1.039    2.771      .080    12
  13    36.74   44.55   15.60  ******  ******  *****   .0045   .0695    .064    .989   .0057   28.4     .999    *****      .067    13
      ------------------------------------------------------------------------------------------------------------------------------
                                         CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS
                         BSHC -------- =   3.821  GRAM/KW-HR          ( 2.850  GRAM/BHP-HR )
                         BSCO -------- =   4.005  GRAM/KW-HR          ( 2.987  GRAM/BHP-HR )
                         BSNOX ------- =   9.134  GRAM/KW-HR          ( 6.814  GRAM/BHP-HR )
                         BSHC + BSNOX  =  12.955  GRAM/KW-HR          ( 9.664  GRAM/BHP-HR )
                         CORR. BSFC -  =    .268   KG/KW-HR           (  .441  LBS/BHP-HR  )
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TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

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                                                                                     PROJECT NO. 11-5044-001
                                            TEST NO.011-9  RUN
ENGINE  NO.011                              DATE  2/27/80
ENGINE  MODEL   79 CUMMINS VT8903                                          DIESEL   EM-408-F
ENGINE 14.8 L(903. CID) V-8                 TIME 01:53                       BAG CART NO.  1
CVS NO.  10                                  DYNO NO.  5

                                            RELATIVE HUMIDITY 40. PCT
BAROMETER 746.25 MM HG(29.38 IN HG)         ABSOLUTE HUMIDITY  8.0 GM/KG( 56.1 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

                                                                                                    4
                                                                          3
                                                      2                                           NYNF
.BAG RESULTS                         1                                   LAF
    BAG NUMBER                     NYNF              LANF            762.0 (30.0)            762.0 (30.0)
    DESCRIPTION                                   762.0 (30.0)       655.3 (25.8)            655.3 (25.8)
    BLOWER DIF P MM. H2O(IN. H2O)  762.0 (30.0)   655.3 (25.8)        48.9 (120.0)            48.9 (120.0)
    BLOWER INLET P MM. H2O(IN. H2O) 655.3 (25.8)   48.9 (120.0)         6368.                   6196.
    BLOWER INLET TEMP. DEG. C(DEG. F) 48.9 (120.0)    6262.             305.0                   296.9
    BLOWER REVOLUTIONS               6175.            300.0          302.6 (10687.)          294.4 (10399.)
    TIME SECONDS                     295.9         297.5 (10509.)
    TOTAL FLOW STD. CU. METRES(SCF) 293.4 (10363.)
                                                                     57.2/22/ 286.           23.7/22/ 119.
                                   19.4/22/  97.   32.4/22/ 162.      6.8/ 1/   7.            7.3/ 1/   7.
    HC   SAMPLE METER/RANGE/PPM     7.1/ 1/   7.    6.7/ 1/   7.     51.0/13/  48.           25.6/13/  23.
    HC   BCKGRD METER/RANGE/PPM    34.5/13/  31.   35.0/13/  32.      1.1/13/   1.            1.8/13/   2.
    CO   SAMPLE METER/RANGE/PPM      .7/13/   1.     .7/13/   1.     57.4/ 3/ 1.01           18.5/ 3/  .30
    CO   BCKGRD METER/RANGE/PPM    21.6/ 3/  .35   27.8/ 3/  .46      3.0/ 3/  .05            2.9/ 3/  .04
    CO2  SAMPLE METER/RANGE/PCT     2.8/ 3/  .04    2.8/ 3/  .04     29.1/13/  87.            4.9/13/  15.
    CO2  BCKGRD METER/RANGE/PCT     5.4/13/  16.    8.8/13/  26.       .8/ 2/   1.             .8/ 2/   1.
    NOX  SAMPLE METER/RANGE/PPM      .7/ 2/   1.     .8/ 2/   1.
    NOX  BCKGRD METER/RANGE/PPM
                                                                       12.83                   43.17
                                     37.05           28.15             280.                    111.
    DILUTION FACTOR                   90.            156.               46.                     21.
    HC   CONCENTRATION PPM            30.             31.               .97                     .25
    CO   CONCENTRATION PPM            .31             .42               86.5                    13.9
    CO2  CONCENTRATION PCT            15.5            25.6
    NOX  CONCENTRATION PPM
                                                                                               18.93
                                     15.22           26.73             48.80                    7.21
    HC   MASS GRAMS                  10.35           10.64             16.12                   1363.7
    CO   MASS GRAMS                 1651.0          2263.3            5370.4                    7.84
    CO2  MASS GRAMS                   8.71           14.56             50.08                   .448 (    .99)
    NOX  MASS GRAMS                  .535 (   1.18)  .738 (   1.63)   1.732 (   3.82)         1.27 (   1.70)
    FUEL KG (LB)                     1.32 (   1.77)  2.20 (   2.95)    7.34 (   9.84)
    KW HR (HP HR)
                                                                                              14.94 (  11.14)
                                    11.54 (   8.60) 12.16 (   9.07)    6.65 (   4.96)          5.69 (   4.25)
    BSHC G/KW HR (G/HP HR)           7.84 (   5.85)  4.84 (   3.61)    2.20 (   1.64)       1076.70 ( 802.89)
    BSCO G/KW HR (G/HP HR)        1251.34 ( 933.12) 1029.29 ( 767.54) 732.10 ( 545.92)        6.19 (   4.61)
    BSCO2 G/KW HR (G/HP HR)          6.60 (   4.92)  6.62 (   4.94)    6.83 (   5.09)          .354 (   .581)
    BSNOX G/KW HR (G/HP HR)          .406 (   .667)  .336 (   .552)    .236 (   .388)
    BSFC KG/KW HR (LB/HP HR)

                                             PARTICULATE DATA, TOTAL FOR 4 BAGS
TOTAL TEST RESULTS 4 BAGS
                                              90MM FILTER
  TOTAL KW HR (HP HR)       12.12 ( 16.25)        SAMPLE FLOW      SCM(SCF)                .895 ( 31.61)
   BSHC   G/KW HR (G/HP HR)  9.05 (  6.75)        MULTIPLIER FOR   G/TEST                 1.327
   BSCO   G/KW HR (G/HP HR)  3.66 (  2.73)        MULTIPLIER FOR   G/KW HR (G/HP HR)      .1095 ( .0817)
   BSCO2  G/KW HR (G/HP HR)  879. (  655.)        MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)  .3843 ( .1743)
   BSNOX  G/KW HR (G/HP HR)  6.70 (  4.99)
   BSFC  KG/KW HR (LB/HP HR) .285 (  .468)
                                              20 X 20 FILTERS
                                                  SAMPLE FLOW      SCM(SCF)             82.57 (2916.3)
                                                                                                              1
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TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE:VTB-903 MALFUNCTION +.004 AND BOOST BLEED OF 4IN.HG
TEST NO. 2 FUEL: EM-408-F PROJECT:11-5428-001 DATE: 3/03/80

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 660.	0.	.0	.022	5.06	4.0	.880	568.	318.	1.14	53.	63.	70.	17.	1
2	2	INTER / 1500.	20.	3.2	.098	12.15	4.0	.884	1136.	252.	1.68	63.	374.	166.	60.	2
3	25	INTER / 1500.	258.	40.5	.212	12.43	4.0	.892	408.	119.	3.80	218.	139.	80.	213.	3
4	50	INTER / 1500.	529.	83.1	.333	13.07	4.0	.901	608.	145.	5.97	555.	211.	97.	548.	4
5	75	INTER / 1500.	773.	121.4	.446	13.39	4.0	.909	1136.	278.	7.80	1005.	409.	191.	1022.	5
6	100	INTER / 1500.	977.	153.4	.620	13.74	4.0	.922	432.	1030.	9.51	1455.	180.	807.	1715.	6
7		IDLE / 660.	0.	.0	.022	5.06	4.0	.880	800.	265.	1.10	99.	90.	60.	32.	7
8	100	RATED / 2100.	868.	190.9	.770	20.95	4.0	.913	616.	278.	7.71	1167.	390.	335.	2096.	8
9	75	RATED / 2100.	604.	132.7	.571	19.45	4.0	.905	976.	199.	5.98	710.	577.	227.	1198.	9
10	50	RATED / 2100.	448.	98.4	.472	18.90	4.0	.901	656.	185.	5.04	465.	379.	208.	769.	10
11	25	RATED / 2100.	156.	34.3	.280	17.95	4.0	.891	488.	159.	3.07	162.	268.	173.	257.	11
12	2	RATED / 2100.	19.	4.2	.197	17.26	4.0	.887	736.	212.	2.13	87.	397.	229.	136.	12
13		IDLE / 660.	0.	.0	.022	5.08	4.0	.880	464.	186.	1.10	56.	53.	43.	18.	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	46.74	52.67	12.60	******	******	*****	.0044	.0695	.064	.989	.0058	31.4	.999	*****	.067	1
2	63.39	28.18	10.16	116.94	51.99	18.74	.0081	.0695	.117	.985	.0086	5.8	1.014	1.819	.080	2
3	10.95	6.29	16.77	3.43	1.97	5.26	.0171	.0695	.246	.967	.0180	5.3	1.018	.308	.080	3
4	10.59	4.88	27.47	2.54	1.17	6.60	.0256	.0695	.368	.950	.0280	9.6	1.021	.235	.080	4
5	15.28	7.12	38.19	3.37	1.57	8.41	.0334	.0695	.481	.936	.0366	9.3	1.025	.215	.080	5
6	4.85	21.71	46.12	1.18	5.26	11.18	.0453	.0695	.652	.923	.0441	-2.6	1.030	.235	.080	6
7	66.99	44.69	23.97	******	******	*****	.0044	.0695	.064	.989	.0057	29.2	1.004	*****	.067	7
8	8.43	7.25	45.35	2.04	1.76	10.98	.0369	.0695	.531	.936	.0359	-2.8	1.069	.227	.080	8
9	16.84	6.64	34.98	4.34	1.71	9.02	.0295	.0695	.424	.950	.0283	-4.0	1.063	.243	.080	9
10	13.37	7.35	27.14	3.85	2.12	7.81	.0251	.0695	.361	.957	.0238	-5.0	1.055	.273	.080	10
11	15.99	10.32	15.29	7.82	5.05	7.48	.0156	.0695	.225	.973	.0147	-6.0	1.045	.468	.080	11
12	33.71	19.39	11.51	95.18	54.74	32.51	.0114	.0695	.164	.981	.0105	-8.3	1.041	2.712	.080	12
13	40.25	32.49	14.04	******	******	*****	.0043	.0695	.062	.989	.0055	27.2	1.000	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

```
BSHC ------- =  4.055  GRAM/KW-HR   ( 3.025  GRAM/BHP-HR )
BSCO ------- =  3.084  GRAM/KW-HR   ( 2.300  GRAM/BHP-HR )
BSNOX ------ =  9.360  GRAM/KW-HR   ( 6.982  GRAM/BHP-HR )
BSHC + BSNOX = 13.414  GRAM/KW-HR   (10.007  GRAM/BHP-HR )
CORR. BSFC - =   .270  KG/KW-HR     (  .444  LBS/BHP-HR  )
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TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

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                                                                                                PROJECT NO. 11-5044-001

ENGINE  NO.D11                              TEST NO.D11-9  RUN
ENGINE  MODEL   79 CUMMINS VTB903           DATE  2/27/80                          DIESEL    EM-408-F
ENGINE 14.8 L(903. CID) V-8                 TIME                                   BAG CART NO.  1
CVS NO.  10                                 DYNO NO.  5

BAROMETER 746.25 MM HG(29.38 IN HG)         RELATIVE HUMIDITY 43. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)       ABSOLUTE HUMIDITY  8.1 GM/KG( 56.5 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                    1                  2                  3                  4
  DESCRIPTION                                 NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)          762.0 (30.0)       762.0 (30.0)       762.0 (30.0)       762.0 (30.0)
  BLOWER INLET P MM. H2O(IN. H2O)        655.3 (25.8)       655.3 (25.8)       655.3 (25.8)       655.3 (25.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                         6177.              6261.              6368.              6198.
  TIME SECONDS                               296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)       293.1 (10353.)     297.1 (10493.)     302.2 (10673.)     294.1 (10388.)

  HC   SAMPLE METER/RANGE/PPM           15.0/22/  75.      30.0/22/ 150.      40.8/22/ 204.      14.6/22/  73.
  HC   BCKGRD METER/RANGE/PPM            9.7/ 1/  10.       9.7/ 1/  10.      10.8/ 1/  11.       9.7/ 1/  10.
  CO   SAMPLE METER/RANGE/PPM           24.2/13/  22.      32.3/13/  29.      46.0/13/  43.      22.5/13/  20.
  CO   BCKGRD METER/RANGE/PPM            1.8/13/   2.       1.1/13/   1.       1.4/13/   1.       1.9/13/   2.
  CO2  SAMPLE METER/RANGE/PCT           18.8/ 3/  .30      26.2/ 3/  .43      59.5/ 3/ 1.05      19.1/ 3/  .31
  CO2  BCKGRD METER/RANGE/PCT            2.9/ 3/  .04       2.8/ 3/  .04       2.6/ 3/  .04       2.8/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM            4.8/13/  14.       9.8/13/  30.      33.0/13/  99.       5.3/13/  16.
  NOX  BCKGRD METER/RANGE/PPM             .9/ 2/   1.        .9/ 2/   1.        .9/ 2/   1.        .8/ 2/   1.

  DILUTION FACTOR                           43.09              30.02              12.44              42.45
  HC   CONCENTRATION PPM                     66.               141.               194.                63.
  CO   CONCENTRATION PPM                     20.                28.                40.                18.
  CO2  CONCENTRATION PCT                     .26                .39               1.02                .26
  NOX  CONCENTRATION PPM                    13.4               28.6               98.3               15.2

  HC   MASS GRAMS                           11.11              24.14              33.82              10.77
  CO   MASS GRAMS                            6.73               9.61              14.22               6.20
  CO2  MASS GRAMS                         1384.8             2106.4             5625.0             1425.0
  NOX  MASS GRAMS                            7.53              16.28              56.83               8.56
  FUEL KG (LB)                          .446 (     .98)   .686 (    1.51)  1.796 (    3.96)   .458 (    1.01)
  KW HR (HP HR)                         1.30 (    1.75)   2.23 (    3.00)   7.32 (    9.81)   1.27 (    1.70)

  BSHC  G/KW HR (G/HP HR)               8.53 (    6.36)  10.80 (    8.06)   4.62 (    3.45)   8.50 (    6.34)
  BSCO  G/KW HR (G/HP HR)               5.17 (    3.86)   4.30 (    3.21)   1.94 (    1.45)   4.89 (    3.65)
  BSCO2 G/KW HR (G/HP HR)            1063.82 (  793.29) 942.83 (  703.07) 768.64 (  573.18) 1125.10 (  838.99)
  BSNOX G/KW HR (G/HP HR)               5.78 (    4.31)   7.29 (    5.43)   7.77 (    5.79)   6.76 (    5.04)
  BSFC  KG/KW HR (LB/HP HR)             .343 (    .564)   .307 (    .505)   .245 (    .403)   .362 (    .595)

TOTAL TEST RESULTS 4 BAGS                          PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)        12.12 ( 16.25)           90MM FILTER
   BSHC   G/KW HR (G/HP HR)   6.59 (  4.91)             SAMPLE FLOW     SCM(SCF)             .919 ( 32.44)
   BSCO   G/KW HR (G/HP HR)   3.03 (  2.26)             MULTIPLIER FOR  G/TEST              1.292
   BSCO2  G/KW HR (G/HP HR)   870. (  649.)             MULTIPLIER FOR  G/KW HR (G/HP HR)   .1066 ( .0795)
   BSNOX  G/KW HR (G/HP HR)   7.36 (  5.49)             MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)  .3814 ( .1730)
   BSFC   KG/KW HR (LB/HP HR) .279 (  .459)           20 X 20 FILTERS
                                                        SAMPLE FLOW     SCM(SCF)            80.93 (2858.5)

1 AB4JCGN. 80/02/28.HOUSTON CYBERNET CENTER SN113 CY-176
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TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

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                                                                                   PROJECT NO. 11-5044-001

ENGINE  NO.D11                          TEST NO.11-10  RUN
ENGINE  MODEL   79 CUMMINS VTB903       DATE  2/28/80                                        -
ENGINE 14.8 L(903. CID) V-8             TIME                              DIESEL   EM-408-F
CVS NO.  10                              DYNO NO.  5                       BAG CART NO.  1

BAROMETER 738.89 MM HG(29.09 IN HG)     RELATIVE HUMIDITY 45. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)   ABSOLUTE HUMIDITY  8.3 GM/KG( 57.6 GRAINS/LB)       NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                 1                  2                  3                  4
  DESCRIPTION                              NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)       736.6 (29.0)       736.6 (29.0)       736.6 (29.0)       736.6 (29.0)
  BLOWER INLET P MM. H2O(IN. H2O)     640.1 (25.2)       640.1 (25.2)       640.1 (25.2)       640.1 (25.2)
  BLOWER INLET TEMP. DEG. C(DEG. F)    48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                       6180.              6262.              6370.              6199.
  TIME SECONDS                             296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)     290.8 (10271.)     294.7 (10407.)     299.7 (10587.)     291.7 (10303.)

  HC   SAMPLE METER/RANGE/PPM         21.6/22/ 108.      34.1/22/ 170.      59.9/22/ 299.      23.0/22/ 115.
  HC   BCKGRD METER/RANGE/PPM          5.9/ 1/   6.       5.6/ 1/   6.       5.2/ 1/   5.       5.9/ 1/   6.
  CO   SAMPLE METER/RANGE/PPM         33.9/13/  31.      34.8/13/  32.      55.7/13/  53.      23.1/13/  21.
  CO   BCKGRD METER/RANGE/PPM           .7/13/   1.        .8/13/   1.       1.0/13/   1.       1.6/13/   1.
  CO2  SAMPLE METER/RANGE/PCT         22.3/ 3/  .36      28.9/ 3/  .48      64.8/ 3/ 1.16      19.3/ 3/  .31
  CO2  BCKGRD METER/RANGE/PCT          2.6/ 3/  .04       2.6/ 3/  .04       2.5/ 3/  .04       2.7/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM          6.3/13/  19.       9.4/13/  28.      32.1/13/  96.       5.5/13/  16.
  NOX  BCKGRD METER/RANGE/PPM          1.0/ 2/   1.       1.0/ 2/   1.       1.0/ 2/   1.       1.0/ 2/   1.

  DILUTION FACTOR                          35.76              27.00              11.22              41.45
  HC   CONCENTRATION PPM                   103.               165.               295.               109.
  CO   CONCENTRATION PPM                    30.                30.                50.                19.
  CO2  CONCENTRATION PCT                    .32                .44               1.12                .27
  NOX  CONCENTRATION PPM                   17.9               27.1               95.4               15.5

  HC   MASS GRAMS                          17.19              28.04              50.93              18.36
  CO   MASS GRAMS                          10.04              10.42              17.59               6.41
  CO2  MASS GRAMS                         1716.3             2362.6             6170.6             1439.6
  NOX  MASS GRAMS                           9.93              15.28              54.70               8.63
  FUEL KG (LB)                        .558 (   1.23)   .770 (   1.70)  1.985 (   4.38)   .471 (   1.04)
  KW HR (HP HR)                       1.39 (   1.86)   2.22 (   2.97)   7.34 (   9.84)   1.27 (   1.70)

  BSHC G/KW HR (G/HP HR)             12.37 (   9.23)  12.65 (   9.43)   6.94 (   5.18)  14.50 (  10.81)
  BSCO G/KW HR (G/HP HR)              7.23 (   5.39)   4.70 (   3.51)   2.40 (   1.79)   5.06 (   3.78)
  BSCO2 G/KW HR (G/HP HR)          1235.01 ( 920.95) 1065.93 ( 794.86) 841.19 ( 627.27) 1136.58 ( 847.55)
  BSNOX G/KW HR (G/HP HR)             7.15 (   5.33)   6.90 (   5.14)   7.46 (   5.56)   6.81 (   5.08)
  BSFC KG/KW HR (LB/HP HR)            .401 (   .660)   .348 (   .571)   .271 (   .445)   .372 (   .611)

TOTAL TEST RESULTS 4 BAGS                               PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)           12.21 ( 16.37)              90MM FILTER
   BSHC   G/KW HR (G/HP HR)      9.38 (  7.00)                 SAMPLE FLOW        SCM(SCF)                .878 ( 31.00)
   BSCO   G/KW HR (G/HP HR)      3.64 (  2.72)                 MULTIPLIER FOR  G/TEST                  1.341
   BSCO2  G/KW HR (G/HP HR)      957. (  714.)                 MULTIPLIER FOR  G/KW HR (G/HP HR)       .1098 ( .0819)
   BSNOX  G/KW HR (G/HP HR)      7.25 (  5.41)                 MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)   .3545 ( .1608)
   BSFC  KG/KW HR (LB/HP HR)     .310 (  .509)
                                                            20 X 20 FILTERS
                                                               SAMPLE FLOW     SCM(SCF)               80.13 (2830.2)
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TABLE B-3 (Cont'd). ENGINE D-11 SUMMARY OF RESULTS
1979 Cummins VTB-903 Coach
Fuel No. 2
Maladjusted Configuration

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                                                                                        PROJECT NO. 11-5044-001

                                             TEST NO.11-10  RUN
ENGINE  NO.D11                               DATE  2/28/80                          DIESEL   EM-408-F
ENGINE  MODEL    79 CUMMINS VTB903           TIME                                   BAG CART NO.  1
ENGINE 14.8 L(903. CID) V-8                  DYNO NO.  5
CVS NO.  10

BAROMETER 738.89 MM HG(29.09 IN HG)          RELATIVE HUMIDITY 45. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)        ABSOLUTE HUMIDITY  8.3 GM/KG( 57.8 GRAINS/LB)       NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                     1                  2                  3                  4
  DESCRIPTION                                  NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)            731.5 (28.8)       731.5 (28.8)       731.5 (28.8)       731.5 (28.8)
  BLOWER INLET P MM. H2O(IN. H2O)          652.8 (25.7)       652.8 (25.7)       652.8 (25.7)       652.8 (25.7)
  BLOWER INLET TEMP. DEG. C(DEG. F)         48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                          6178.              6264.              6370.              6201.
  TIME SECONDS                               295.9              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)          290.5 (10260.)     294.5 (10403.)     299.5 (10579.)     291.6 (10299.)

  HC  SAMPLE METER/RANGE/PPM               17.5/22/  88.      29.3/22/ 147.      41.6/22/ 208.      14.3/22/  71.
  HC  BCKGRD METER/RANGE/PPM               14.2/ 1/  14.      10.2/ 1/  10.      10.6/ 1/  11.       9.0/ 1/   9.
  CO  SAMPLE METER/RANGE/PPM               48.2/13/  45.      41.8/13/  39.      52.3/13/  50.      23.0/13/  21.
  CO  BCKGRD METER/RANGE/PPM               29.0/13/  26.      12.6/13/  11.       5.1/13/   4.       3.9/13/   3.
  CO2 SAMPLE METER/RANGE/PCT               19.4/ 3/  .31      28.2/ 3/  .46      63.1/ 3/ 1.12      18.5/ 3/  .30
  CO2 BCKGRD METER/RANGE/PCT                3.1/ 3/  .05       2.6/ 3/  .04       2.7/ 3/  .04       2.8/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                5.6/13/  17.      10.6/13/  32.      36.4/13/ 109.       5.9/13/  18.
  NOX BCKGRD METER/RANGE/PPM                 .8/ 2/   1.        .7/ 2/   1.        .5/ 2/   1.        .5/ 2/   1.

  DILUTION FACTOR                            41.27              27.79              11.65              43.88
  HC  CONCENTRATION PPM                      74.               137.               198.                62.
  CO  CONCENTRATION PPM                      19.                27.                44.                17.
  CO2 CONCENTRATION PCT                      .27                .43               1.09                .25
  NOX CONCENTRATION PPM                     16.2               31.0              108.9               17.1

  HC  MASS GRAMS                            12.36              23.24              34.26              10.51
  CO  MASS GRAMS                             6.48               9.36              15.26               5.73
  CO2 MASS GRAMS                          1410.7             2294.7             5962.9             1358.6
  NOX MASS GRAMS                             8.98              17.47              62.39               9.54
  FUEL KG (LB)                              .456 (   1.00)     .744 (   1.64)    1.902 (   4.19)     .437 (    .96)
  KW HR (HP HR)                             1.30 (   1.75)     2.23 (   3.00)     7.34 (   9.84)     1.27 (   1.70)

  BSHC G/KW HR (G/HP HR)                    9.49 (   7.08)    10.40 (   7.76)     4.67 (   3.48)     8.30 (   6.19)
  BSCO G/KW HR (G/HP HR)                    4.98 (   3.71)     4.19 (   3.12)     2.08 (   1.55)     4.52 (   3.37)
  BSCO2 G/KW HR (G/HP HR)                1083.65 ( 808.08)  1027.11 ( 765.92)   812.88 ( 606.16)  1072.62 ( 799.85)
  BSNOX G/KW HR (G/HP HR)                   6.90 (   5.14)     7.82 (   5.83)     8.51 (   6.34)     7.54 (   5.62)
  BSFC KG/KW HR (LB/HP HR)                  .350 (   .575)     .333 (   .547)     .259 (   .426)     .345 (   .567)

                                          PARTICULATE DATA, TOTAL FOR 4 BAGS
TOTAL TEST RESULTS 4 BAGS
                                              90MM FILTER                                     .906 ( 32.01)
  TOTAL KW HR (HP HR)            12.14 ( 16.28)    SAMPLE FLOW      SCM(SCF)                 1.298
   BSHC    G/KW HR (G/HP HR)      6.62 (  4.94)    MULTIPLIER FOR   G/TEST                   .1069 ( .0797)
   BSCO    G/KW HR (G/HP HR)      3.03 (  2.26)    MULTIPLIER FOR   G/KW HR (G/HP HR)        .3667 ( .1663)
   BSCO2   G/KW HR (G/HP HR)      908. (  677.)    MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)
   BSNOX   G/KW HR (G/HP HR)      8.11 (  6.04)
   BSFC   KG/KW HR (LB/HP HR)     .292 (  .479)       20 X 20 FILTERS                         80.57 (2845.6)
                                                     SAMPLE FLOW     SCM(SCF)

1 AB4JPNW. 80/02/29.HOUSTON CYBERNET CENTER SN113 CY-176
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TABLE B-4. SPECIFIC HYDROCARBON EMISSION RATES FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION

		1500 rpm				2100 rpm		
Hydrocarbon	Rate	2	50	100	Idle	100	50	2
Methane	µg/m^3	2030	1170[a]	886[a]	1570[a]	979[a]	959[a]	1450[a]
CH_4	mg/hr	1260	777	650	401	1120	968	1280
	mg/kg fuel	222	41	19	227	25	40	168
	mg/kW-hr	495	10	4	--	6	10	307
Ethylene	µg/m^3	7430	711	2500	3580	2070	1010	4100
C_2H_4	mg/hr	4600	474	1840	915	2370	1020	3620
	mg/kg fuel	812	25	54	517	53	42	475
	mg/kW-hr	1810	6	11	--	12	11	866
Ethane	µg/m^3	137	0[a]	44	56	56	0[a]	81
C_2H_6	mg/hr	85	0	32	14	64	0	72
	mg/kg fuel	15	0	1	8	1	0	9
	mg/kW-hr	34	0	0	-	0	0	17
Acetylene	µg/m^3	49	5[b]	11[b]	22[b]	11[b]	11[b]	33[b]
C_2H_2	mg/hr	30	4	8	6	12	11	27
	mg/kg fuel	5	0	0	3	0	0	4
	mg/kW-hr	12	0	0	-	0	0	7
Propane	µg/m^3	156	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
C_3H_8	mg/hr	102	0	0	0	0	0	0
	mg/kg fuel	18	0	0	0	0	0	0
	mg/kW-hr	40	0	0	0	0	0	0
Propylene	µg/m^3	3500	274	1180	1590	1090	454	1780
C_3H_6	mg/hr	2160	182	867	406	1240	459	1570
	mg/kg fuel	382	10	25	230	28	19	207
	mg/kW-hr	852	2	5	-	6	5	377
Benzene	µg/m^3	691	0	332	1430	2050	2950	2750
C_6H_6	mg/hr	412	0	234	352	2250	2860	2340
	mg/kg fuel	73	0	7	199	50	117	307
	mg/kW-hr	162	0	2	-	12	31	559
Toluene	µg/m^3	1080	0[a]	0[a]	718	0[a]	0[a]	767
C_7H_8	mg/hr	666	0	0	183	0	0	676
	mg/kg fuel	118	0	0	103	0	0	89
	mg/kW-hr	262	0	0	-	0	0	162

[a] Sample concentration lower than background concentration

[b] Uncertain due to minimal detection

TABLE B-5. SPECIFIC HYDROCARBON EMISSION RATES FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION

Hydrocarbon	Rate	1500 rpm			Idle	2100 rpm		
		2	50	100		100	50	2
Methane	μg/m^3	2730	872[a]	1520[a]	2120	2160	1010[a]	2040
CH_4	mg/hr	1690	582	1070	536	2310	970	1750
	mg/kg fuel	276	29	29	378	50	35	161
	mg/kW-hr	526	7	7	-	12	10	452
Ethylene	μg/m^3	18500	5660	40300	7950	53400	10200	12800
C_2H_4	mg/hr	11400	3780	28500	2000	57000	9840	11000
	mg/kg fuel	1870	189	775	1420	1240	356	1010
	mg/kW-hr	3560	45	187	-	296	100	2830
Ethane	μg/m^3	318	100	687	156	1270	181	212
C_2H_6	mg/hr	197	67	485	39	1360	175	182
	mg/kg fuel	32	3	13	28	30	6	17
	mg/kW-hr	61	1	3	-	7	2	47
Acetylene	μg/m^3	119	43[b]	179	54	217	54	97
C_2H_2	mg/hr	73	29	126	14	231	52	84
	mg/kg fuel	12	1	3	10	5	2	8
	mg/kW-hr	23	0	1	-	1	1	22
Propane	μg/m^3	75	0	0	0	121	0	0
C_3H_8	mg/hr	49	0	0	0	137	0	0
	mg/kg fuel	8	0	0	0	3	0	0
	mg/kW-hr	15	0	0	0	1	0	0
Propylene	μg/m^3	9050	2810	15600	3530	24000	5450	5910
C_3H_6	mg/hr	5590	1880	11000	890	25600	5260	5080
	mg/kg fuel	913	94	300	629	559	190	467
	mg/kW-hr	1740	23	72	-	133	53	1310
Benzene[c]	μg/m^3	702	270	2500	236	4580	197[a]	1060
C_6H_6	mg/hr	417	173	1700	57	4700	182	874
	mg/kg fuel	68	9	46	40	103	7	80
	mg/kW-hr	130	2	11	-	24	2	225
Toluene[c]	μg/m^3	1290[a]	4690	14700	2840	0	12500	6900
C_7H_8	mg/hr	797	3120	10300	714	0	12000	5910
	mg/kg fuel	130	156	283	504	0	434	543
	mg/kW-hr	248	38	68	-	0	122	1520

[a] Sample concentration lower than background concentration

[b] Uncertain due to minimal detection

[c] Benzene and toluene traces show signs of severe interference during processing samples and standards

TABLE B-6. SUMMARY OF TRANSIENT INDIVIDUAL HYDROCARBONS FROM CUMMINS VTB-903

Configuration	Units	Methane	Ethylene	Ethane	Acetylene	Propane	Propylene	Benzene	Toluene	Total
Baseline Cold 1	mg/test	0.0[a]	1230	30.9	6.4	72.2	593	0.0	0.0	
Baseline Cold 2	mg/test	39.3	1140	0.0	6.4	0.0	503	0.0	0.0	
Avg	mg/test	19.6	1185	15.4	6.4	36.1	548	0.0	0.0	
	mg/kW-hr	1.60	97.0	1.26	0.52	2.95	44.8	0.0	0.0	148
	mg/kg-fuel	5.65	343	4.45	1.84	10.4	158	0.0	0.0	523
Baseline Hot 1	mg/test	0.0[a]	745	24.6	0.0	0.0	372	0.0	0.0	
Baseline Hot 2	mg/test	0.0	795	16.3	0.0	0.0	379	0.0	0.0	
Avg	mg/test	0.0	770	20.4	0.0	0.0	376	0.0	0.0	
	mg/kW-hr	0.0	63.1	1.67	0.0	0.0	30.8	0.0	0.0	95.6
	mg/kg-fuel	0.0	236	6.20	0.0	0.0	115	0.0	0.0	358
Maladjusted Cold 1	mg/test	87.9	2480	66.5	12.8	14.4	1250	38.4	58.2	
Maladjusted Cold 2	mg/test	58.5	2340	81.2	12.8	7.2	1220	--[b]	--[b]	
Avg	mg/test	73.2	2410	73.8	12.8	10.8	1235	38.4	58.2	
	mg/kW-hr	6.02	198	6.07	1.05	0.89	101	3.16	4.78	321
	mg/kg-fuel	20.2	664	20.4	3.52	2.99	339	10.6	16.0	1077
Maladjusted Hot 1	mg/test	0.0[a]	2170	30.9	0.0	0.0	1130	57.6	64.7	
Maladjusted Hot 2	mg/test	0.0	2400	24.2	0.0	0.0	1270	122	--[b]	
Avg	mg/test	0.0	2285	27.6	0.0	0.0	1200	89.8	64.7	
	mg/kW-hr	0.0	188	2.27	0.0	0.0	98.9	7.40	5.33	302
	mg/kg-fuel	0.0	657	7.94	0.0	0.0	346	25.9	18.6	1056

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[a] Any background methane concentration of 2.54 ppm was higher than the sample

[b] Chromatographic interference - indeterminate

TABLE B-7. ALDEHYDES BY DNPH FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION

		1500 rpm				2100 rpm		
Aldehyde	Rate	2	50	100	Idle	100	50	2
Formaldehyde	μg/m³	24[b]	823	1880	1250	278	93	1040
	mg/hr	15	547	1370	318	316	93	920
	mg/kg fuel	3	29	40	180	7	4	121
	mg/kW-hr	6	7	9	-	2	1	220
Acetaldehyde	μg/m³	0	71	0	382	261	0	141
	mg/hr	0	47	0	97	297	0	124
	mg/kg fuel	0	3	0	55	7	0	16
	mg/kW-hr	0	1	0	-	2	0	30
Acetone	μg/m³	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Isobutyraldehyde	μg/m³	161[a]	0	0	278[a]	792	459	1200
	mg/hr	99	0	0	71	900	461	1050
	mg/kg fuel	17	0	0	40	20	19	138
	mg/kW-hr	39	0	0	-	5	5	252
Methyl Ethyl Ketone	μg/m³	0	0	0	33[b]	0	0	34[b]
	mg/hr	0	0	0	8	0	0	30
	mg/kg fuel	0	0	0	5	0	0	4
	mg/kW-hr	0	0	0	-	0	0	7
Crotonaldehyde	μg/m³	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Hexanaldehyde	μg/m³	0	36[b]	106[b]	0	38[b]	0	43[b]
	mg/hr	0	24	78	0	44	0	38
	mg/kg fuel	0	1	2	0	1	0	5
	mg/kW-hr	0	0	1	0	0	0	9
Benzaldehyde	μg/m³	0[a]	98[b]	0[a]	351	227	89[b]	567
	mg/hr	0	65	0	89	258	89	499
	mg/kg fuel	0	3	0	50	6	4	66
	mg/kW-hr	0	1	0	-	1	1	119

[a] Background higher than sample
[b] Uncertain due to low concentration

TABLE B-8. ALDEHYDES BY DNPH FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION

		1500 rpm				2100 rpm		
Aldehyde	Rate	2	50	100	Idle	100	50	2
Formaldehyde	$\mu g/m^3$	0	2490	559	7280	8420	5560	9300
	mg/hr	0	1650	393	1830	8950	5350	7980
	mg/kg fuel	0	83	11	1290	195	193	732
	mg/kW-hr	0	20	3	-	47	54	2060
Acetaldehyde	$\mu g/m^3$	0	84	58	1340	508	781	1580
	mg/hr	0	56	41	338	540	751	1360
	mg/kg fuel	0	3	1	238	12	27	125
	mg/kW-hr	0	1	0	-	3	8	350
Acetone	$\mu g/m^3$	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Isobutyraldehyde	$\mu g/m^3$	326[a]	197[a]	338	1430	0	0	1750
	mg/hr	201	131	238	360	0	0	1500
	mg/kg fuel	33	7	7	255	0	0	138
	mg/kW-hr	63	2	2	-	0	0	386
Methyl Ethyl Ketone	$\mu g/m^3$	0	47[b]	0	184	31[b]	146	233
	mg/hr	0	31	0	46	32	140	199
	mg/kg fuel	0	2	0	33	1	5	18
	mg/kW-hr	0	0	0	-	0	1	51
Crotonaldehyde	$\mu g/m^3$	0	0	0	0	0	0	0
	mg/hr	0	0	0	0	0	0	0
	mg/kg fuel	0	0	0	0	0	0	0
	mg/kW-hr	0	0	0	0	0	0	0
Hexanaldehyde	$\mu g/m^3$	0	35[b]	0	132	0	160	222
	mg/hr	0	24	0	33	0	154	190
	mg/kg fuel	0	1	0	23	0	6	18
	mg/kW-hr	0	0	0	-	0	2	49
Benzaldehyde	$\mu g/m^3$	64[a,b]	170[a]	37[a,b]	2350	566	355	616
	mg/hr	40	113	26	590	600	341	526
	mg/kg fuel	7	6	1	417	13	12	48
	mg/kW-hr	12	1	0	-	3	4	135

[a] Sample concentration lower than background
[b] Uncertain due to minimal detection limits

TABLE B-9. SUMMARY OF TRANSIENT ALDEHYDES BY DNPH FROM CUMMINS VTB-903

Configuration	Units	Formal-dehyde	Acetal-dehyde	Acetone	Isobutyr-aldehyde	Methyl Ethyl Ketone	Crontal-dehyde	Hexanal-dehyde	Banzal-dehyde	Total
Baseline Cold 1	mg/test	651	1040	66.3^{b}	0.0^{a}	194	0.0	0.0	1280	
Baseline Cold 2	mg/test	824	1100	0.0	149^{b}	42.6	0.0	0.0	361	
Avg	mg/test	737	1070	33.2	74.5	118	0.0	0.0	820	
	mg/kW-hr	60.4	87.6	2.72^{b}	6.10^{a,b}	9.68^{b}	0.0	0.0	67.1	234
	mg/kg-fuel	213	310	9.61^{b}	21.6^{a,b}	34.2^{b}	0.0	0.0	237	825
Baseline Hot 1	mg/test	0.0	240	0.0	92.3^{b}	0.0	0.0	0.0	755	
Baseline Hot 2	mg/test	606	181	0.0	0.0^{a}	0.0	0.0	0.0	42.6	
Avg	mg/test	303	211	0.0	46.1	0.0	0.0	0.0	398.8	
	mg/kW-hr	24.8	17.2	0.0	3.78^{a,b}	0.0	0.0	0.0	32.7	78.5
	mg/kg-fuel	92.9	64.4	0.0	14.2^{a,b}	0.0	0.0	0.0	122	294
Maladjusted Cold 1	mg/test	619	221	0.0	0.0	15.4^{b}	0.0	0.0	49.7^{b}	
Maladjusted Cold 2	mg/test	721	141	0.0	21.2^{b}	27.2^{b}	0.0	34.3^{b}	315	
Avg	mg/test	670	181	0.0	13.6	21.3	0.0	17.2	182.4	
	mg/kW-hr	55.1	14.9	0.0	1.12^{b}	1.75^{b}	0.0	1.41^{b}	15.0^{b}	89.3
	mg/kg-fuel	185	49.9	0.0	3.75^{b}	5.87^{b}	0.0	4.74^{b}	50.3^{b}	300
Maladjusted Hot 1	mg/test	396	85.2	0.0	0.0	0.0	0.0	0.0	22.4^{b}	
Maladjusted Hot 2	mg/test	1080	123	31.96	0.0	18.9^{b}	0.0	0.0	690	
Avg	mg/test	738	104.1	16.0	0.0	9.4	0.0	0.0	356	
	mg/kW-hr	60.8	8.58	1.32^{b}	0.0	0.78^{b}	0.0	0.0	29.3^{b}	101
	mg/kg-fuel	213	30.0	4.61^{b}	0.0	2.71^{b}	0.0	0.0	103^{b}	353

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[a] Background sample higher than sample
[b] Uncertain due to minimal detection

TABLE B-10. PHENOLS FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION

		1500 rpm			2100 rpm	
Phenol	Rate	2	50	Idle	100	50
Phenol	μg/m^3	101	0	233	0	0
	mg/hr	62.6		59.7		
	mg/kW-hr	24.7		--		
	mg/kg fuel	11.1		33.7		
Salecyl-aldehyde-	μg/m^3	31	0	0	0	0
	mg/hr	19				
	mg/hW-hr	7.6				
	mg/kg-fuel	3.4				
m-Cresol + p-cresol	μg/m^3	0	0	0	0	0
	mg/hr					
	mg/kW-hr					
	mg/kg-fuel					
p-ethl-2-isopropyl-methyl-	μg/m^3	354	0	112	0	5
	mg/hr	219		28.7		5
	mg/kW-hr	86.6		--		0.05
	mg/kg fuel	38.9		16.2		0.2
2,3,5-tri-methyl-	μg/m^3	0	0	0	0	0
	mg/hr					
	mg/kW-hr					
	mg/kg-fuel					
2,3,5,6-tetra-methyl-	μg/m^3	0	0	0	0	0
	mg/hr					
	mg/kW-hr					
	mg/kg-fuel					
2-n-propyl-	μg/m^3	230	0	0	0	0
	mg/hr	142				
	mg/kW-hr	56.3				
	mg/kg-fuel	25.3				

TABLE B-11. PHENOLS FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION

		1500 rpm			2100 rpm	
Phenol	Rate	2	50	Idle	100	50
Phenol	$\mu g/m^3$	0	0	173	0	81
	mg/hr			43.7		78
	mg/kW-hr			--		0.59
	mg/kg-fuel			30.9		2.8
Salecylaldehyde-	$\mu g/m^3$	0	0	0	106	0
	mg/hr				113	
	mg/kW-hr				0.59	
	mg/kg-fuel				2.5	
m-Cresol + p-Cresol	$\mu g/m^3$	0	0	0	0	0
	mg/hr					
	mg/kw-hr					
	mg/kg-fuel					
p-ethl-2-isopropyl-methyl-	$\mu g/m^3$	0	0	1160	0	887
	mg/hr			294		857
	mg/kW-hr			--		8.71
	mg/kg-fuel			208		31.0
2,3,5-trimethyl-	$\mu g/m^3$	0	0	0	0	0
	mg/hr					
	mg/kW-hr					
	mg/kg-fuel					
2,3,5,6-tetramethyl-	$\mu g/m^3$	0	0	0	27000	0
	mg/hr				29000	
	mg/hW-hr				150	
	mg/kg-fuel				630	
2-n-propyl-	$\mu g/m^3$	0	40	1040	0	544
	mg/hr		26.7	263		525
	mg/kW-hr		0.32	--		5.34
	mg/kg-fuel		1.34	186		19.0

TABLE B-12. SUMMARY OF TRANSIENT PHENOLS FROM CUMMINS VTB-903

Configuration	Units	Phenol	Salicy-aldehyde	m-cresol and p-cresol	p-ethylphenol 2-isopropyl-phenol,2,3 methylphenol	2,3,5-trimethyl phenol	2,3,5,6-tetramethyl phenol	2-n-propylphenol
Baseline Cold 1	µg/m^3	--	12	--	--	--	--	--
Baseline Cold 2	µg/m^3	99	--	--	--	--	218	--
Avg	µg/m^3	50	6.0	--	--	--	109	--
	mg/test	59	7.1	--	--	--	129	--
	mg/kW-hr	4.8	0.58	--	--	--	10.5	--
	mg/kg-fuel	17	2.0	--	--	--	37.2	--
Baseline Hot 1	µg/m^3	--	10	12	--	--	--	22
Baseline Hot 2	µg/m^3	88	13	--	--	--	163	9
Avg	µg/m^3	44	12	6.0	--	--	82	16
	mg/test	52	14	7.1	--	--	96	19
	mg/kW-hr	4.2	1.2	0.53	--	--	7.9	1.5
	mg/kg-fuel	16	4.3	2.2	--	--	29.5	5.8
Maladjusted Cold 1	µg/m^3	--	--	--	150	--	--	--
Maladjusted Cold 2[a]	µg/m^3	--	--	--	--	--	--	--
Avg	µg/m^3	--	--	--	150	--	--	--
	mg/test	--	--	--	177	--	--	--
	mg/kW-hr	--	--	--	14.5	--	--	--
	mg/kg-fuel	--	--	--	48.8	--	--	--
Maladjusted Hot 1	µg/m^3	--	7.0	--	20	--	--	71
Maladjusted Hot 2[a]	µg/m^3	--	--	--	--	--	--	--
Avg	µg/m^3	--	7.0	--	20	--	--	71
	mg/test	--	8.0	--	24	--	--	84
	mg/kW-hr	--	0.7	--	1.9	--	--	6.9
	mg/kg-fuel	--	2.0	--	6.8	--	--	24

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[a] no results, sample voided

TABLE B-13. SUMMARY OF MODAL PARTICULATE FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION[a]

Engine rpm/% load	Concentration mg/m^3	Particulate Rate g/hr	Particulate Rate g/kg fuel	Particulate Rate g/kW-hr
1500/2	43.99	27.56	5.06	8.59
1500/25	27.54	17.86	1.99	0.43
1500/50	33.68	22.87	1.28	0.28
1500/75	29.01	20.00	0.74	0.17
1500/100	39.00	27.92	0.82	0.18
Idle	22.58	6.01	3.40	--
2100/100	25.81	28.85	0.65	0.15
2100/75	23.67	24.57	0.70	0.17
2100/50	24.82	26.32	1.01	0.27
2100/25	30.47	29.66	1.68	0.86
2100/2	45.55	39.57	4.96	10.20

[a] Particulate rate based on 90 mm Pallflex with back-up filter

TABLE B-14. SUMMARY OF MODAL PARTICULATE FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION[a]

Engine rpm/% load	Concentration, mg/m^3	Particulate Rate		
		g/hr	g/kg fuel	g/kW-hr
1500/2	100.28	63.65	11.70	16.73
1500/25	38.96	25.79	2.35	0.64
1500/50	44.74	30.75	1.47	0.37
1500/75	44.70	30.71	1.16	0.25
1500/100	66.45	48.05	1.32	0.31
Idle	56.80	15.60	11.10	--
2100/100	40.55	45.15	0.99	0.24
2100/75	44.12	44.97	1.31	0.34
2100/50[b]	51.96	51.78	1.90	0.53
2100/25	47.76	43.97	2.69	1.28
2100/2[b]	72.10	64.53	7.91	27.03

[a] Particulate rate based on 90 mm Pallflex with back-up filter

[b] Particulate rate based on average of 90 mm, 20x20, and 2 runs of 47 mm Pallflex, filter efficiency applied uniformly

TABLE B-15. SUMMARY OF MODAL SULFATE FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION

Engine rpm/% load	Run No.	Concentration, $\mu g/m^3$	Sulfate Rate			$SO_4^=$ as % Fuel S
			mg/hr	mg/kg fuel	mg/kW-hr	
1500/2	1	1218	763	140	238	1.67
	2	1055	661	121	206	1.44
	Avg.	1137	712	131	222	1.56
1500/25	1	1926	1249	139	30	1.65
	2	2449	1588	177	38	2.11
	Avg.	2188	1419	158	34	1.88
1500/50	1	5447	3699	206	44	2.45
	2	5011	3403	190	42	2.26
	Avg.	5229	3551	198	43	2.36
1500/75	1	5544	3822	140	31	1.67
	2	5578	3845	141	32	1.68
	Avg.	5561	3834	141	32	1.68
1500/100	1	6519	4662	137	29	1.63
	2	5588	3996	117	25	1.39
	Avg.	6054	4329	127	27	1.51
Idle[a]	1	346	92	52	--	0.62
	2	955	254	144	--	1.71
	Avg.	651	173	98	--	1.17
2100/100	1	5812	6496	146	33	1.74
	2	5586	6243	140	32	1.67
	Avg.	5699	6370	143	33	1.71
2100/75	1	5936	6162	174	42	2.07
	2	5852	6075	172	42	2.05
	Avg.	5894	6119	173	42	2.06
2100/50	1	3905	4141	159	42	1.89
	2	4680	4963	190	50	2.26
	Avg.	4293	4552	175	46	2.08
2100/25	1	2794	2720	154	79	1.83
	2	2690	2619	148	76	1.76
	Avg.	2742	2670	151	78	1.80
2100/2[a]	1[b]	1392	1209	151	312	1.80
	2	590	513	64	132	0.76
	Avg.	991	861	108	222	1.28

[a] Runs were not repeatable--possible filter holder leak due to problems with Fluoropore filter plugging

[b] Fluoropore filter plugged

TABLE B-16. SUMMARY OF MODAL SULFATE FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION

Engine rpm/% load	Run No.	Concentration, μg/m^3	Sulfate Rate			$SO_4^=$ as % Fuel S
			mg/hr	mg/kg fuel	mg/kW-hr	
1500/2[a]	1[b]	1670	1060	195	279	2.32
	2	585	371	68	98	0.81
	Avg.	1128	716	132	189	1.57
1500/25	1	1638	1084	99	27	1.18
	2	2234	1479	135	37	1.61
	Avg.	1936	1282	117	32	1.40
1500/50	1	4849	3333	159	40	1.89
	2	3915	2691	128	32	1.52
	Avg.	4382	3012	144	36	1.71
1500/75	1	4498	3090	116	25	1.38
	2	5006	3439	130	28	1.55
	Avg.	4752	3265	123	27	1.47
1500/100	1	4948	3578	98	23	1.17
	2	4489	3246	89	21	1.06
	Avg.	4719	3412	94	22	1.12
Idle[a]	1	921	253	180	--	2.14
	2	579	159	113	--	1.34
	Avg.	750	206	147	--	1.74
2100/100	1	5156	5741	126	31	1.50
	2	4382	4880	107	26	1.27
	Avg.	4769	5311	117	29	1.39
2100/75	1	4754	4846	141	36	1.68
	2	4450	4536	132	34	1.57
	Avg.	4602	4691	137	35	1.63
2100/50	1	4780	4764	175	48	2.08
	2	3793	3780	139	38	1.65
	Avg.	4287	4272	157	43	1.87
2100/25	1	1358	1250	77	36	0.92
	2	1842	1696	104	49	1.24
	Avg.	1600	1473	91	43	1.08
2100/2[a]	1	1229	1100	135	461	1.61
	2	406	363	44	152	0.52
	Avg.	818	732	90	307	1.07

[a] Runs were not repeatable--possible filter holder leak due to problems with Fluoropore filter plugging

[b] Fluoropore filter plugged

TABLE B-17. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES FROM CUMMINS VTB-903 IN BASELINE CONFIGURATION (13-Mode FTP Weighting Factors)

						Weighted			
Engine rpm/% load	Power kW	Fuel kg/hr	Part.[a] g/hr	$SO_4^{=}$ [b] mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^{=}$ mg/hr
Idle	--	1.8	6.01	173	0.067	--	0.1	0.40	11.6
1500/2	3.2	5.4	27.56	712	0.08	0.3	0.4	2.20	57.0
1500/25	41.3	9.0	17.86	1419	0.08	3.3	0.7	1.43	113.5
1500/50	80.9	17.9	22.87	3551	0.08	6.5	1.4	1.83	284.1
1500/75	121.4	27.2	20.00	3834	0.08	9.7	2.2	1.60	306.7
1500/100	159.3	34.2	27.92	4329	0.08	12.7	2.7	2.23	346.3
Idle	--	1.8	6.01	173	0.067	--	0.1	0.40	11.6
2100/100	195.4	44.5	28.85	6370	0.08	15.6	3.6	2.30	509.6
2100/75	145.5	35.4	24.57	6119	0.08	11.6	2.8	1.97	489.5
2100/50	98.4	26.1	26.32	4552	0.08	7.9	2.1	2.11	364.2
2100/25	34.3	17.7	29.66	2670	0.08	2.7	1.4	2.37	213.6
2100/2	3.9	8.0	39.57	861	0.08	0.3	0.6	3.17	68.9
Idle	--	1.8	6.01	173	0.067	--	0.1	0.40	11.6
						70.6	18.2	22.41	2788.2

	13-mode	7-mode
Brake Specific Particulate, g/kW-hr	0.32	0.33
Fuel Specific Particulate, g/kg fuel	1.23	1.30
Brake Specific $SO_4^{=}$, mg/kW-hr	39.5	38.9
Fuel Specific $SO_4^{=}$, mg/kg fuel	153.2	152.0

[a] Particulate rate based on 90 mm Pallflex filter sample taken over two runs.

[b] Sulfate rate based on separate 47 mm Fluoropore filter samples from two runs, then averaged

TABLE B-18. CYCLE COMPOSITE PARTICULATE AND SULFATE RATES FROM CUMMINS VTB-903 IN MALADJUSTED CONFIGURATION (13-Mode FTP Weighting Factors)

						Weighted			
Engine rpm/% load	Power kW	Fuel kg/hr	Part.[a] g/hr	$SO_4^=$[b] mg/hr	Wgt. Fact.	Power kW	Fuel kg/hr	Part. g/hr	$SO_4^=$ mg/hr
Idle	--	1.4	15.60	206	0.067	--	0.1	1.05	13.8
1500/2	3.8	5.4	63.65	716	0.08	0.3	0.4	5.09	57.3
1500/25	40.5	11.0	25.79	1282	0.08	3.2	0.9	2.06	102.6
1500/50	83.1	21.0	30.75	3012	0.08	6.6	1.7	2.46	241.0
1500/75	121.4	26.5	30.71	3265	0.08	9.7	2.1	2.46	261.2
1500/100	153.4	36.4	48.05	3412	0.08	12.3	2.9	3.84	273.0
Idle	--	1.4	15.60	206	0.067	--	0.1	1.05	13.8
2100/100	192.4	45.6	45.15	5311	0.08	15.4	3.6	3.61	424.9
2100/75	132.7	34.3	44.97	4691	0.08	10.6	2.7	3.60	375.3
2100/50	98.4	27.2	51.78[c]	4272	0.08	7.9	2.2	4.14	341.8
2100/25	34.3	16.3	43.97	1473	0.08	2.7	1.3	3.52	117.8
2100/2	2.4	8.2	64.53[c]	732	0.08	0.2	0.7	5.16	58.6
Idle	--	1.4	15.60	206	0.067	--	0.1	1.05	13.8
						68.9	18.8	39.09	2294.9

	13-mode	7-mode
Brake Specific Particulate, g/kW-hr	0.57	0.60
Fuel Specific Particulate, g/kg fuel	2.08	2.21
Brake Specific $SO_4^=$, mg/kW-hr	33.3	34.0
Fuel Specific $SO_4^=$, mg/kg fuel	122.1	124.8

[a] Particulate rate based on 90 mm Pallflex filter sample taken over two runs.

[b] Sulfate rate based on separate 47 mm Fluoropore filter samples from two runs.

[c] Particulate rate based on average of 90 mm, 20x20, and two 47 mm particulate samples.

TABLE B-19. SUMMARY OF COLD-HOT START TRANSIENT SULFATE RESULTS FROM CUMMINS VTB-903 IN BOTH BASELINE AND MALADJUSTED CONFIGURATIONS

Engine Configuration	Run No.	Sulfate mg/test	Sulfate mg/kW-hr	Sulfate mg/kg fuel	$SO_4^=$ as %[a] of Fuel S
Baseline Cold Start	1	446	36.5	125	1.48
	2	395	32.3	110	1.31
	Avg.	421	34.4	118	1.40
Baseline Hot Start	1	441	36.1	131	1.56
	2	515	42.2	153	1.83
	Avg.	478	39.2	142	1.70
Baseline Composite		470	38.4	139	1.65
Maladjusted Cold Start	1	656	53.9	181	2.15
	2	558	45.9	154	1.83
	Avg.	607	49.9	168	1.99
Maladjusted Hot Start	1	380	31.3	110	1.30
	2	361	29.8	104	1.24
	Avg.	371	30.6	107	1.27
Maladjusted Composite		405	33.4	116	1.37

[a] Fuel Used: SwRI EM-408-F, No. 2-D Fuel with 0.28 wt. % S

APPENDIX C

EMISSION RESULTS FROM THE DDAD 6V-71N IN BASELINE AND MALADJUSTED CONFIGURATIONS

TABLE C-1. NOTES CONCERNING HOT START TRANSIENT TESTING DURING MALADJUSTMENT OF BASELINE ENGINE

Maladjustment Hot Start	
C-2	Six 50,000 mile injectors were substituted into the baseline engine. Racks were adjusted to specification. Injection timing was maintained same as baseline. Passed statistical requirements. HC and NOx were taken by bag only.
C-3	Injection timing was retarded by 0.020 inch on each injector for a retard of approximately 2.8 crank angle degree. Passed statistical requirements. HC and NOx were taken by bag only.
C-4	Adjustments to throttle delay were made in order to null the effect of the mechanism. Passed statistical requirements. HC and NOx were taken by bag only.
C-5	Intake air restriction was increased from 17 in. H_2O to 25 in. H O as measured during maximum power conditions. Passed statistical requirements. HC and NOx were measured and were reported as taken by bag and by continuous on-line instrumentation.

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                       +50,000 MILE INJECTORS
                TABLE C-2.  ENGINE EMISSION RESULTS
                               H-TRANS                               PROJECT NO. 05-5830-008

ENGINE   NO.D28                      TEST NO.D28-7  RUN1
ENGINE   MODEL    78 DDAD 6V-71COACH DATE   5/22/81
ENGINE   7.0 L(426. CID)             TIME                       DIESEL    EM-465-F
CVS NO.   10                           DYNO NO.  5                BAG CART NO.  1

BAROMETER 737.62 MM HG(29.04 IN HG)  RELATIVE HUMIDITY ,  ENGINE-42. PCT ,  CVS-62. PCT
DRY BULB TEMP. 28.9 DEG C(84.0 DEG F) ABSOLUTE HUMIDITY 10.8 GM/KG( 75.6 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                               1                2                3                4
  DESCRIPTION                             NYNF             LANF             LAF              NYNF
  BLOWER DIF P MM. H2O(IN. H2O)        228.6 ( 9.0)     228.6 ( 9.0)     228.6 ( 9.0)     228.6 ( 9.0)
  BLOWER INLET P MM. H2O(IN. H2O)      180.3 ( 7.1)     180.3 ( 7.1)     180.3 ( 7.1)     180.3 ( 7.1)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)     48.9 (120.0)     48.9 (120.0)     48.9 (120.0)
  BLOWER REVOLUTIONS                      3326.            3371.            3427.            3337.
  TIME SECONDS                            296.0            300.0            305.0            297.0
  TOTAL FLOW STD. CU. METRES(SCF)      158.2 (   5588.) 160.3 ( 5663.)  163.0 ( 5757.)  158.7 ( 5606.)

  HC  SAMPLE METER/RANGE/PPM          23.7/ 2/  24.    36.5/ 2/  37.    58.9/ 2/  59.    45.4/ 2/  45.
  HC  BCKGRD METER/RANGE/PPM          10.6/ 2/  11.    11.4/ 2/  11.    11.5/ 2/  12.    11.8/ 2/  12.
  CO  SAMPLE METER/RANGE/PPM          75.8/13/  74.    91.2/13/  92.    88.0/12/ 215.    69.4/13/  67.
  CO  BCKGRD METER/RANGE/PPM           1.4/13/   1.     1.3/13/   1.     .7/12/   1.     1.3/13/   1.
  CO2 SAMPLE METER/RANGE/PCT          25.4/ 3/  .41    36.9/ 3/  .62    85.0/ 3/ 1.57    25.6/ 3/  .42
  CO2 BCKGRD METER/RANGE/PCT           3.0/ 3/  .05     2.7/ 3/  .04     3.0/ 3/  .05     2.8/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM          35.3/ 2/  35.    46.5/ 2/  47.    39.3/ 3/ 118.    36.2/ 2/  36.
  NOX BCKGRD METER/RANGE/PPM            .6/ 2/   1.      .5/ 2/   1.      .2/ 3/   1.      .4/ 2/   0.

  DILUTION FACTOR                        31.59            21.17             8.38            31.22
  HC  CONCENTRATION PPM                   13.              26.              49.              34.
  CO  CONCENTRATION PPM                   71.              88.             203.              64.
  CO2 CONCENTRATION PCT                   .37              .58             1.53              .38
  NOX CONCENTRATION PPM                  34.7             46.0            117.4             35.8

  HC  MASS GRAMS                         1.23             2.37             4.59             3.11
  CO  MASS GRAMS                        13.12            16.41            38.48            11.92
  CO2 MASS GRAMS                       1072.3           1706.5           4577.1           1094.7
  NOX MASS GRAMS                        10.51            14.12            36.60            10.87
  FUEL KG (LB)                       .346 (     .76)  .549 (    1.21)  1.467 (    3.23)   .354 (     .78)
  KW HR (HP HR)                       .97 (    1.30)  1.50 (    2.01)   4.84 (    6.49)    .90 (    1.20)

  BSHC G/KW HR (G/HP HR)             1.26 (     .94)  1.58 (    1.18)    .95 (     .71)   3.46 (    2.58)
  BSCO G/KW HR (G/HP HR)            13.49 (   10.06) 10.96 (    8.19)   7.95 (    5.93)  13.28 (    9.90)
  BSCO2 G/KW HR (G/HP HR)         1102.45 (  822.10) 1140.41 ( 850.40) 946.00 ( 705.43) 1219.29 ( 909.23)
  BSNOX G/KW HR (G/HP HR)           10.80 (    8.06)  9.43 (    7.03)   7.56 (    5.64)  12.11 (    9.03)
  BSFC KG/KW HR (LB/HP HR)          .356 (    .585)  .367 (    .603)   .303 (    .499)   .395 (    .649)

TOTAL TEST RESULTS 4 BAGS                   PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)         8.21 (  11.00)      90MM FILTER
   BSHC    G/KW HR (G/HP HR)  1.38 (   1.03)        SAMPLE FLOW     SCM(SCF)                 .820 ( 28.97)
   BSCO    G/KW HR (G/HP HR)  9.74 (   7.26)        MULTIPLIER FOR  G/TEST                   .781
   BSCO2   G/KW HR (G/HP HR) 1030. (   768.)        MULTIPLIER FOR  G/KW HR (G/HP HR)        .0951 ( .0709)
   BSNOX   G/KW HR (G/HP HR)  8.79 (   6.55)        MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)    .2874 ( .1304)
   BSFC   KG/KW HR (LB/HP HR)  .331 (   .544)
                                                  20 X 20 FILTERS
                                                    SAMPLE FLOW    SCM(SCF)                  0.00 (   0.0)
PART. G/KW-HR (G/HP-HR) 0.94 (0.70)
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Bag

Bag

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                                        + TIMING RETARD
                                 TABLE  C-3.ENGINE EMISSION RESULTS
                                                 H-TRANS                                              PROJECT NO. 05-5830-008

ENGINE  NO.D28                                  TEST NO.D28-8  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH              DATE  5/22/81
ENGINE  7.0 L(426. CID)                         TIME 11:40                           DIESEL   EM-465-F
CVS NO.  10                                      DYNO NO.  5                          BAG CART NO.  1

BAROMETER 737.87 MM HG(29.05 IN HG)             RELATIVE HUMIDITY ,  ENGINE-40. PCT ,  CVS-60. PCT
DRY BULB TEMP. 28.9 DEG C(84.0 DEG F)           ABSOLUTE HUMIDITY 10.3 GM/KG( 71.9 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                        1                  2                  3                  4
  DESCRIPTION                                     NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)              228.6 ( 9.0)       228.6 ( 9.0)       228.6 ( 9.0)       228.6 ( 9.0)
  BLOWER INLET P MM. H2O(IN. H2O)            180.3 ( 7.1)       180.3 ( 7.1)       180.3 ( 7.1)       180.3 ( 7.1)
  BLOWER INLET TEMP. DEG. C(DEG. F)           48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                            3326.              3371.              3428.              3337.
  TIME SECONDS                                  296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)            158.3 (   5590.)   160.4 ( 5666.)     163.1 ( 5761.)     158.8 ( 5608.)

  HC  SAMPLE METER/RANGE/PPM                 26.3/ 2/  26.      40.4/ 2/  40.      60.4/ 2/  60.      45.2/ 2/  45.
  HC  BCKGRD METER/RANGE/PPM                 11.4/ 2/  11.      13.3/ 2/  13.      13.2/ 2/  13.      14.2/ 2/  14.
  CO  SAMPLE METER/RANGE/PPM                 73.9/13/  72.      54.4/12/ 117.      71.6/11/ 305.      81.0/13/  80.
  CO  BCKGRD METER/RANGE/PPM                   .4/13/   0.        .3/12/   1.        .4/11/   1.        .7/13/   1.
  CO2 SAMPLE METER/RANGE/PCT                 25.3/ 3/  .41      37.0/ 3/  .62      86.4/ 3/ 1.60      24.9/ 3/  .41
  CO2 BCKGRD METER/RANGE/PCT                  2.3/ 3/  .04       2.1/ 3/  .03       2.3/ 3/  .04       2.4/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                 28.4/ 2/  28.      36.3/ 2/  36.      88.8/ 2/  89.      27.4/ 2/  27.
  NOX BCKGRD METER/RANGE/PPM                   .5/ 2/   1.        .5/ 2/   1.        .8/ 2/   1.        .6/ 2/   1.

  DILUTION FACTOR                               31.72              21.01               8.18              32.04
  HC  CONCENTRATION PPM                         15.                28.                49.                31.
  CO  CONCENTRATION PPM                         70.               113.               289.                78.
  CO2 CONCENTRATION PCT                          .38                .59               1.57                .37
  NOX CONCENTRATION PPM                         27.9               35.8               88.1               26.0

  HC  MASS GRAMS                                 1.39               2.57               4.59               2.88
  CO  MASS GRAMS                                12.92              21.07              54.82              14.33
  CO2 MASS GRAMS                              1097.9             1738.4             4696.3             1076.9
  NOX MASS GRAMS                                 8.45              10.99              27.49               8.15
  FUEL KG (LB)                                  .354 (     .78)   .561 (    1.24)   1.513 (    3.34)    .350 (     .77)
  KW HR (HP HR)                                  .92 (    1.24)   1.46 (    1.96)    4.80 (    6.44)     .90 (    1.20)

  BSHC G/KW HR (G/HP HR)                        1.51 (    1.13)   1.76 (    1.31)     .96 (     .71)    3.21 (    2.39)
  BSCO G/KW HR (G/HP HR)                       14.00 (   10.44)  14.44 (   10.77)   11.42 (    8.52)   15.96 (   11.90)
  BSCO2 G/KW HR (G/HP HR)                    1189.82 ( 887.25) 1191.53 ( 888.53)  978.20 ( 729.45) 1199.49 ( 894.46)
  BSNOX G/KW HR (G/HP HR)                       9.16 (    6.83)   7.53 (    5.62)    5.73 (    4.27)    9.07 (    6.77)
  BSFC KG/KW HR (LB/HP HR)                      .384 (    .631)   .385 (    .632)    .315 (    .518)    .389 (    .640)

TOTAL TEST RESULTS 4 BAGS                         PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)            8.08 ( 10.84)          90MM FILTER
  BSHC    G/KW HR (G/HP HR)      1.41 (  1.05) Bag          SAMPLE FLOW     SCM(SCF)                    .840 ( 29.66)
  BSCO    G/KW HR (G/HP HR)     12.76 (  9.52)              MULTIPLIER FOR  G/TEST                      .763
  BSCO2   G/KW HR (G/HP HR)     1065. (  795.)              MULTIPLIER FOR  G/KW HR (G/HP HR)           .0944 ( .0704)
  BSNOX   G/KW HR (G/HP HR)      6.82 (  5.08) Bag          MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)       .2746 ( .1246)
  BSFC   KG/KW HR (LB/HP HR)     .344 (  .565)
                                                        20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 1.34 (1.00)                       SAMPLE FLOW     SCM(SCF)                    0.00 (   0.0)
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                                    + NO THROTTLE DELAY
                           TABLE C-4. ENGINE EMISSION RESULTS
                                          H-TRANS.                                  PROJECT NO. 05-5830-008

ENGINE   NO.D28                           TEST NO.D28-9   RUN1
ENGINE   MODEL    78 DDAD 6V-71COACH      DATE   5/22/81
ENGINE   7.0 L(426. CID)                  TIME                             DIESEL    EM-465-F
CVS NO.   10                                DYNO NO.  5                     BAG CART NO.  1

BAROMETER 736.35 MM HG(28.99 IN HG)       RELATIVE HUMIDITY ,  ENGINE-35. PCT ,  CVS-57. PCT
DRY BULB TEMP. 30.6 DEG C(87.0 DEG F)     ABSOLUTE HUMIDITY  9.9 GM/KG( 69.3 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                   1                2                3                4
  DESCRIPTION                                NYNF             LANF              LAF             NYNF
  BLOWER DIF P MM. H2O(IN. H2O)          228.6 ( 9.0)     228.6 ( 9.0)     228.6 ( 9.0)     228.6 ( 9.0)
  BLOWER INLET P MM. H2O(IN. H2O)        180.3 ( 7.1)     180.3 ( 7.1)     180.3 ( 7.1)     180.3 ( 7.1)
  BLOWER INLET TEMP. DEG. C(DEG. F)       48.9 (120.0)     48.9 (120.0)     48.9 (120.0)     48.9 (120.0)
  BLOWER REVOLUTIONS                        3326.            3370.            3428.            3338.
  TIME SECONDS                             296.0            299.9            305.0            297.0
  TOTAL FLOW STD. CU. METRES(SCF)        157.9 (   5578.)  160.0 ( 5652.)   162.8 ( 5749.)   158.5 ( 5598.)

  HC   SAMPLE METER/RANGE/PPM            26.4/ 2/  26.    37.9/ 2/  38.    58.5/ 2/  59.    43.7/ 2/  44.
  HC   BCKGRD METER/RANGE/PPM            11.1/ 2/  11.    11.2/ 2/  11.    12.1/ 2/  12.    11.9/ 2/  12.
  CO   SAMPLE METER/RANGE/PPM            92.0/13/  93.    66.0/12/ 148.    73.2/11/ 315.    81.5/13/  81.
  CO   BCKGRD METER/RANGE/PPM              .7/13/   1.      .4/12/   1.      .3/11/   1.      .9/13/   1.
  CO2  SAMPLE METER/RANGE/PCT            25.5/ 3/  .42    38.5/ 3/  .65    86.6/ 3/ 1.61    25.8/ 3/  .42
  CO2  BCKGRD METER/RANGE/PCT             2.6/ 3/  .04     2.9/ 3/  .04     2.9/ 3/  .04     2.9/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM            28.5/ 2/  29.    37.1/ 2/  37.    89.3/ 2/  89.    28.1/ 2/  28.
  NOX  BCKGRD METER/RANGE/PPM              .5/ 2/   1.      .3/ 2/   0.      .5/ 2/   1.      .3/ 2/   0.

  DILUTION FACTOR                          31.31            20.06             8.16            30.89
  HC   CONCENTRATION PPM                    16.              27.              48.              32.
  CO   CONCENTRATION PPM                    90.             143.             299.              78.
  CO2  CONCENTRATION PCT                    .38              .61             1.57              .38
  NOX  CONCENTRATION PPM                   28.0             36.8             88.9             27.8

  HC   MASS GRAMS                          1.43             2.52             4.50             2.94
  CO   MASS GRAMS                         16.51            26.58            56.67            14.38
  CO2  MASS GRAMS                        1092.8           1781.1           4674.5           1099.0
  NOX  MASS GRAMS                          8.46            11.27            27.67             8.43
  FUEL KG (LB)                             .354 (    .78)   .578 (   1.27)  1.507 (   3.32)   .357 (    .79)
  KW HR (HP HR)                            .94 (   1.25)   1.52 (   2.04)   4.89 (   6.56)    .90 (   1.20)

  BSHC G/KW HR (G/HP HR)                  1.52 (   1.14)   1.65 (   1.23)    .92 (    .69)   3.28 (   2.44)
  BSCO G/KW HR (G/HP HR)                 17.65 (  13.16)  17.47 (  13.03)  11.59 (   8.65)  16.02 (  11.95)
  BSCO2 G/KW HR (G/HP HR)              1168.44 ( 871.31) 1170.73 ( 873.01) 956.28 ( 713.10) 1224.06 ( 912.78)
  BSNOX G/KW HR (G/HP HR)                 9.05 (   6.75)   7.41 (   5.52)   5.66 (   4.22)   9.39 (   7.00)
  BSFC KG/KW HR (LB/HP HR)                .379 (   .623)   .380 (   .624)   .308 (   .507)   .398 (   .654)

TOTAL TEST RESULTS 4 BAGS                      PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)           8.24 ( 11.05)          90MM FILTER
   BSHC   G/KW HR (G/HP HR)     1.38 (  1.03) Bag          SAMPLE FLOW      SCM(SCF)                .856 ( 30.24)
   BSCO   G/KW HR (G/HP HR)    13.85 ( 10.33)              MULTIPLIER FOR   G/TEST                  .747
   BSCO2  G/KW HR (G/HP HR)    1049. (  782.)              MULTIPLIER FOR   G/KW HR (G/HP HR)       .0906 ( .0675)
   BSNOX  G/KW HR (G/HP HR)     6.77 (  5.05) Bag          MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)   .2670 ( .1211)
   BSFC   KG/KW HR (LB/HP HR)   .339 (  .558)
                                                       20 X 20 FILTERS
                                                          SAMPLE FLOW     SCM(SCF)                  0.00 (   0.0)
PART. G/KW-HR (G/HP-HR) 1.45 (1.08)
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+ INCREASED AIR RESTRICTION

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                                   TABLE  C-5. ENGINE EMISSION RESULTS
                                                H-TRANS.                                          PROJECT NO. 05-5830-008

ENGINE  NO.D28                              TEST NO.D28-1  RUN1
ENGINE  MODEL    78 DDAD 6V-71COACH         DATE  5/25/81
ENGINE  7.0 L(426. CID)                     TIME                                  DIESEL    EM-465-F
CVS NO.  10                                   DYNO NO.  5                           BAG CART NO.  1

BAROMETER 736.09 MM HG(28.98 IN HG)         RELATIVE HUMIDITY ,  ENGINE-50. PCT ,  CVS-50. PCT
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)       ABSOLUTE HUMIDITY 11.3 GM/KG( 79.3 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                     1                  2                    3                    4
  DESCRIPTION                                  NYNF               LANF                  LAF                 NYNF
  BLOWER DIF P MM. H2O(IN. H2O)            241.3 ( 9.5)       241.3 ( 9.5)        241.3 ( 9.5)        241.3 ( 9.5)
  BLOWER INLET P MM. H2O(IN. H2O)          182.9 ( 7.2)       182.9 ( 7.2)        182.9 ( 7.2)        182.9 ( 7.2)
  BLOWER INLET TEMP. DEG. C(DEG. F)         48.9 (120.0)       48.9 (120.0)        48.9 (120.0)        48.9 (120.0)
  BLOWER REVOLUTIONS                          3326.              3371.               3428.               3337.
  TIME SECONDS                               296.0              300.0               305.0               297.0
  TOTAL FLOW STD. CU. METRES(SCF)          157.5 (   5564.)   159.7 ( 5639.)      162.4 ( 5734.)      158.0 ( 5582.)

  HC  SAMPLE METER/RANGE/PPM               10.8/23/  54.      14.6/23/  73.       22.7/23/ 113.       16.7/23/  84.
  HC  BCKGRD METER/RANGE/PPM                6.8/ 2/   7.       6.3/ 2/   6.        7.0/ 2/   7.        7.0/ 2/   7.
  CO  SAMPLE METER/RANGE/PPM               95.7/13/  97.      70.1/12/ 160.       79.7/11/ 360.       91.5/13/  92.
  CO  BCKGRD METER/RANGE/PPM                1.6/13/   1.        .8/12/   1.         .8/11/   2.        1.9/13/   2.
  CO2 SAMPLE METER/RANGE/PCT               25.7/ 3/  .42      38.1/ 3/  .64       87.8/ 3/ 1.63       26.0/ 3/  .43
  CO2 BCKGRD METER/RANGE/PCT                3.0/ 3/  .05       3.2/ 3/  .05        3.1/ 3/  .05        2.6/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM               10.6/13/  32.      14.2/13/  42.       33.5/13/ 100.       10.9/13/  33.
  NOX BCKGRD METER/RANGE/PPM                 .5/ 2/   1.        .4/ 2/   0.        1.5/ 2/   2.         .6/ 2/   1.

  DILUTION FACTOR                            30.83              20.14                7.99               30.29
  HC  CONCENTRATION PPM                      47.                67.                 107.                 77.
  CO  CONCENTRATION PPM                      93.               154.                 341.                 88.
  CO2 CONCENTRATION PCT                       .38                .60                1.59                 .39
  NOX CONCENTRATION PPM                      31.2               42.1                99.1                32.0

  HC  MASS GRAMS                              4.31               6.19               10.04                7.01
  CO  MASS GRAMS                             17.13              28.55               64.48               16.26
  CO2 MASS GRAMS                           1082.9             1742.5              4729.5              1119.0
  NOX MASS GRAMS                              9.40              12.86               30.78                9.67
  FUEL KG (LB)                               .354 (      .78)   .570 (     1.26)   1.534 (     3.38)    .368 (      .81)
  KW HR (HP HR)                               .92 (     1.24)   1.52 (     2.04)    4.88 (     6.54)     .90 (     1.20)

  BSHC G/KW HR (G/HP HR)                     4.67 (     3.48)   4.07 (     3.03)    2.06 (     1.54)    7.80 (     5.82)
  BSCO G/KW HR (G/HP HR)                    18.56 (    13.84)  18.77 (    13.99)   13.22 (     9.86)   18.11 (    13.51)
  BSCO2 G/KW HR (G/HP HR)                 1173.52 (   875.09) 1145.41 (  854.13)  970.00 (   723.33) 1246.31 (   929.38)
  BSNOX G/KW HR (G/HP HR)                   10.18 (     7.59)   8.45 (     6.30)    6.31 (     4.71)   10.78 (     8.04)
  BSFC KG/KW HR (LB/HP HR)                   .384 (     .631)   .375 (     .616)    .315 (     .517)    .410 (     .674)

TOTAL TEST RESULTS 4 BAGS                    PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.22 ( 11.02)     90MM FILTER
  BSHC   G/KW HR (G/HP HR)     3.35 (  2.50)        SAMPLE FLOW      SCM(SCF)                 .863 ( 30.48)
  BSCO   G/KW HR (G/HP HR)    15.38 ( 11.47)        MULTIPLIER FOR   G/TEST                   .739
  BSCO2  G/KW HR (G/HP HR)    1056. (  787.)        MULTIPLIER FOR   G/KW HR (G/HP HR)        .0899 ( .0670)
  BSNOX  G/KW HR (G/HP HR)     7.63 (  5.69)        MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)    .2614 ( .1186)
  BSFC  KG/KW HR (LB/HP HR)    .344 (  .565)
                                                 20 X 20 FILTERS
                                                    SAMPLE FLOW     SCM(SCF)                  0.00 (   0.0)
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PART. G/KW-HR (G/HP-HR) 1.45 (1.08)
BSHC G/KW-HR (G/HP-HR) 1.38 (1.03) Bag
BSNOX G/KW-HR (G/HP-HR) 6.89 (5.14) Bag

TABLE C-6. 13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: DDAD 6V-71 COACH NO.1 DIESEL , BASELINE BAROMETER 29.18
TEST NO. 01-01 FUEL: EM-400-F PROJECT:11-5830-008 DATE: 05/12/81

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 400.	0.	.0	.014	3.48	7.1	.959	208.	101.	.73	130.	23.	22.	44.	1
2	2	INTER / 1260.	15.	2.0	.063	12.09	7.1	.959	272.	146.	1.05	100.	96.	103.	110.	2
3	25	INTER / 1260.	186.	24.5	.128	12.02	7.1	.959	248.	80.	2.18	215.	88.	56.	237.	3
4	50	INTER / 1260.	373.	49.2	.203	12.02	7.1	.959	248.	61.	3.67	380.	84.	40.	394.	4
5	75	INTER / 1260.	559.	73.7	.292	11.94	7.1	.958	264.	159.	5.34	565.	90.	104.	580.	5
6	100	INTER / 1260.	746.	98.4	.416	11.83	7.1	.958	216.	5775.	7.25	820.	74.	3703.	822.	6
7		IDLE / 400.	0.	.0	.014	3.46	7.1	.959	224.	101.	.73	135.	24.	22.	46.	7
8	100	RATED / 2100.	597.	131.2	.596	18.45	7.1	.958	316.	1139.	6.63	840.	177.	1212.	1397.	8
9	75	RATED / 2100.	448.	98.4	.471	18.50	7.1	.958	328.	173.	5.19	500.	186.	188.	850.	9
10	50	RATED / 2100.	298.	65.6	.349	18.53	7.1	.959	328.	90.	3.92	335.	180.	96.	559.	10
11	25	RATED / 2100.	149.	32.8	.242	18.61	7.1	.959	328.	93.	2.66	215.	181.	101.	365.	11
12	2	RATED / 2100.	12.	2.7	.153	18.75	7.1	.959	336.	103.	1.68	120.	183.	111.	202.	12
13		IDLE / 400.	0.	.0	.014	3.52	7.1	.959	232.	114.	.81	160.	23.	22.	49.	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	27.56	26.78	53.97	******	******	*****	.0039	.0687	.057	.992	.0036	-7.6	.991	*****	.067	1
2	25.20	26.98	28.93	48.75	52.21	55.98	.0053	.0687	.077	.989	.0052	-1.5	1.011	1.914	.080	2
3	11.45	7.29	30.68	3.60	2.29	9.65	.0108	.0687	.157	.979	.0105	-2.5	1.011	.311	.080	3
4	6.94	3.33	32.41	1.71	.82	8.00	.0170	.0687	.247	.965	.0174	2.8	1.011	.244	.080	4
5	5.16	5.96	33.12	1.22	1.42	7.86	.0246	.0687	.358	.951	.0252	2.3	1.010	.235	.080	5
6	2.95	*****	32.94	.75	37.62	8.35	.0354	.0687	.516	.932	.0365	3.1	1.011	.251	.080	6
7	29.62	26.73	55.93	******	******	*****	.0040	.0687	.058	.992	.0036	-8.0	.987	*****	.067	7
8	4.96	33.92	39.10	1.35	9.24	10.65	.0325	.0687	.474	.940	.0315	-3.1	1.048	.260	.080	8
9	6.57	6.66	30.10	1.89	1.91	8.64	.0256	.0687	.373	.952	.0245	-4.3	1.049	.274	.080	9
10	8.59	4.58	26.69	2.74	1.46	8.52	.0190	.0687	.276	.963	.0187	-1.7	1.049	.304	.080	10
11	12.46	6.94	25.12	8.51	3.07	11.11	.0131	.0687	.191	.974	.0128	-2.3	1.050	.421	.080	11
12	19.82	12.05	21.98	67.99	41.34	75.38	.0082	.0687	.120	.983	.0082	-.5	1.051	3.263	.080	12
13	27.72	27.23	59.84	******	******	*****	.0039	.0687	.057	.991	.0040	3.5	.988	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- = 2.414 GRAM/KW-HR (1.801 GRAM/BHP-HR)
BSCO ------- = 9.971 GRAM/KW-HR (7.439 GRAM/BHP-HR)
BSNOX ------ = 9.732 GRAM/KW-HR (7.260 GRAM/BHP-HR)
BSHC + BSNOX = 12.146 GRAM/KW-HR (9.061 GRAM/BHP-HR)
CORR. BSFC - = .296 KG/KW-HR (.487 LBS/BHP-HR)

TABLE C-7. 13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: DDAD 6V-71 COACH NO.1 DIESEL , BASELINE
TEST NO. 01-01 FUEL: EM-400-F PROJECT:11-5830-008

BAROMETER 29.18
DATE: 05/12/81

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 400.	0.	.0	.014	3.55	6.1	.940	192.	119.	.81	160.	19.	23.	48.	1
2	2	INTER / 1260.	14.	1.8	.063	12.09	6.1	.940	260.	146.	1.18	130.	82.	92.	126.	2
3	25	INTER / 1260.	186.	24.5	.128	12.09	6.1	.941	236.	80.	2.23	235.	82.	56.	248.	3
4	50	INTER / 1260.	373.	49.2	.203	12.09	6.1	.942	236.	58.	3.60	390.	82.	39.	405.	4
5	75	INTER / 1260.	559.	73.7	.292	12.02	6.1	.943	252.	159.	5.34	575.	86.	104.	581.	5
6	100	INTER / 1260.	746.	98.4	.416	11.94	6.1	.944	216.	5735.	7.16	830.	74.	3722.	830.	6
7		IDLE / 400.	0.	.0	.014	3.54	6.1	.940	220.	98.	.69	130.	25.	22.	46.	7
8	100	RATED / 2100.	599.	131.8	.596	18.57	6.1	.944	312.	1126.	6.72	820.	173.	1183.	1327.	8
9	75	RATED / 2100.	449.	98.7	.471	18.61	6.1	.943	324.	159.	5.34	470.	179.	168.	765.	9
10	50	RATED / 2100.	300.	65.9	.349	18.65	6.1	.942	328.	88.	3.92	330.	180.	94.	541.	10
11	25	RATED / 2100.	149.	32.8	.242	18.63	6.1	.941	328.	93.	2.66	210.	181.	101.	360.	11
12	2	RATED / 2100.	12.	2.7	.153	18.74	6.1	.941	328.	101.	1.68	115.	178.	109.	190.	12
13		IDLE / 400.	0.	.0	.014	3.52	6.1	.940	236.	106.	.81	165.	23.	21.	49.	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	GRAMS/KW-HR HC	GRAMS/KW-HR CO	GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	23.03	28.55	58.90	******	******	*****	.0039	.0687	.056	.991	.0040	4.1	.989	*****	.067	1
2	21.57	24.13	32.98	46.91	51.37	70.20	.0053	.0687	.077	.988	.0058	10.2	1.007	2.114	.080	2
3	10.67	7.14	32.20	3.35	2.24	10.12	.0107	.0687	.166	.978	.0107	.4	1.005	.313	.080	3
4	6.73	3.22	33.33	1.66	.80	8.23	.0169	.0687	.245	.966	.0171	1.5	1.005	.246	.080	4
5	4.92	5.96	33.17	1.17	1.42	7.88	.0244	.0687	.356	.951	.0252	3.0	1.005	.236	.080	5
6	2.98	*****	33.27	.76	37.81	8.43	.0350	.0687	.510	.933	.0361	2.9	1.004	.252	.080	6
7	30.71	27.40	55.76	******	******	*****	.0039	.0687	.056	.992	.0034	-10.9	.982	*****	.067	7
8	4.84	33.10	37.12	1.31	8.97	10.06	.0323	.0687	.470	.939	.0319	-1.1	1.044	.260	.080	8
9	6.32	5.95	27.08	1.81	1.70	7.75	.0255	.0687	.371	.951	.0252	-1.0	1.044	.274	.080	9
10	8.59	4.48	25.84	2.73	1.42	8.21	.0188	.0687	.274	.964	.0187	-1.0	1.044	.305	.080	10
11	12.45	6.94	24.09	5.51	3.07	10.65	.0131	.0687	.190	.975	.0128	-2.1	1.046	.423	.080	11
12	19.36	11.83	20.68	66.39	40.56	70.90	.0082	.0687	.120	.983	.0082	-.5	1.046	3.277	.080	12
13	28.21	25.34	60.51	******	******	*****	.0039	.0687	.057	.991	.0040	3.8	.986	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC -------- = 2.334 GRAM/KW-HR (1.741 GRAM/BHP-HR)
BSCO -------- = 9.872 GRAM/KW-HR (7.365 GRAM/BHP-HR)
BSNOX ------- = 9.458 GRAM/KW-HR (7.055 GRAM/BHP-HR)
BSHC + BSNOX = 11.792 GRAM/KW-HR (8.797 GRAM/BHP-HR)
CORR. BSFC - = .297 KG/KW-HR (.488 LBS/BHP-HR)

TABLE C-8. 13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: DDAD 6V-71 COACH NO,1 DIESEL, MALFUNCTION CONFIG, BAROMETER 29,05
TEST: 02-01 FUEL: EM-400-F PROJECT:05-5428-001 DATE: 5/27/81

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 400.	0.	.0	,014	3,47	13,2	1,121	168,	133,	,85	130,	16,	25,	44,	1
2	2	INTER / 1260.	14.	1.8	.067	11,62	12,7	1,106	248,	239,	1,18	90,	82,	157,	106,	2
3	25	INTER / 1260.	174.	22.9	.125	11.61	11,5	1,066	220,	127,	2,28	155,	73,	83,	177,	3
4	50	INTER / 1260.	349.	46.0	.199	11,62	11,5	1,055	196,	133,	3,54	235,	68,	90,	273,	4
5	75	INTER / 1260,	522,	68.9	.292	11,62	11,5	1,042	224,	586,	5,34	345,	76,	382,	382,	5
6	100	INTER / 1260.	697.	92.0	.423	11,42	11.5	1,023	116,	8104,	6,89	520,	41,	5386,	577,	6
7		IDLE / 400.	0.	.0	.014	3,48	11,5	1,078	144,	106,	,81	135,	14,	21,	47,	7
8	100	RATED / 2100.	564.	124.1	.611	17,83	12.5	1,041	164,	2646,	6,98	520,	89,	2695,	900,	8
9	75	RATED / 2100.	423.	93.1	.490	17,83	12.5	1,053	200,	559,	5,73	290,	107,	571,	509,	9
10	50	RATED / 2100.	282.	62,0	.358	17,83	12,7	1,075	232,	127,	4,12	200,	125,	132,	366,	10
11	25	RATED / 2100.	141.	31.0	.246	18.02	12,0	1,069	260,	106,	2,77	130,	140,	112,	240,	11
12	2	RATED / 2100.	11.	2,4	.157	18,02	12.0	1,078	280,	114,	1,73	80,	152,	123,	151,	12
13		IDLE / 400.	0.	.0	,014	3.47	11,5	1,078	192,	114,	,89	120,	17,	20,	38,	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	19.30	30.49	54.51	******	******	*****	.0040	,0687	,058	,989	,0042	5,7	,995	*****	,067	1
2	20.47	39.25	26.68	45.64	87.52	59.49	.0058	.0687	,084	,986	,0059	1,0	1,019	2,187	,080	2
3	9.73	11.07	23.51	3.20	3.64	7.73	.0109	,0687	,159	,977	,0110	,5	1,018	,323	,080	3
4	5.68	7.51	22.86	1.49	1.95	5.93	.0173	,0687	,252	,966	,0168	-2,7	1,018	,255	,080	4
5	4.35	21.81	21.84	1.11	5.54	5.55	.0254	,0687	,370	,950	,0254	-,2	1,017	,250	,080	5
6	1.61	*****	22.70	.45	58.54	6.27	.0375	,0687	,546	,933	,0359	-4,1	1,018	,271	,080	6
7	17.42	25.62	57.41	******	******	*****	.0040	,0687	,058	,990	,0040	,8	,995	*****	,067	7
8	2.42	73.54	24.55	.71	21.72	7.25	.0347	,0687	,505	,935	,0337	-2,7	1,065	,277	,080	8
9	3.64	19.43	17.32	1.15	6.13	5.47	.0278	,0687	,405	,946	,0271	-2,5	1,066	,296	,080	9
10	5.81	6.17	17.04	2.01	2.13	5.89	.0203	,0687	,296	,960	,0195	-3,7	1,068	,324	,080	10
11	9.53	7.62	16.31	4.53	3.62	7.75	.0138	,0687	,201	,972	,0133	-3,7	1,067	,445	,080	11
12	16.12	13.00	16.05	63.72	51.39	63.45	.0088	,0687	,129	,982	,0084	-4,7	1,068	3,703	,080	12
13	21.09	24.99	46.27	******	******	*****	.0040	.0687	,058	,989	,0044	10,8	,993	*****	,067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- = 1,823 GRAM/KW-HR (1,360 GRAM/BHP-HR)
BSCO ------- = 17,981 GRAM/KW-HR (13,414 GRAM/BHP-HR)
BSNOX ------ = 6,963 GRAM/KW-HR (5,194 GRAM/BHP-HR)
BSHC + BSNOX = 8,786 GRAM/KW-HR (6,554 GRAM/BHP-HR)
CORR. BSFC - = ,316 KG/KW-HR (,520 LBS/BHP-HR)

TABLE C-9. 13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: DDAD 6V-71 COACH NO.1 DIESEL, MALFUNCTION CONFIG. BAROMETER 29.03
TEST: 02-02 FUEL: EM-400-F PROJECT:05-5428-001 DATE: 5/27/81

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS N X M	POWER OBS KW	FUEL FLOW KG/MIN	AIR FLOW KG/MIN	INTAKE HUMID G/KG	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 400.	0.	.0	.016	3.41	11.7	1.074	196.	88.	.85	130.	21.	19.	50.	1
2	2	INTER / 1260.	19.	1.8	.065	11.76	11.7	1.072	252.	154.	1.18	90.	82.	99.	102.	2
3	25	INTER / 1260.	174.	22.9	.124	11.77	11.7	1.064	216.	111.	2.23	155.	73.	74.	179.	3
4	50	INTER / 1260.	349.	46.0	.199	11.57	11.7	1.054	216.	93.	3.60	245.	74.	62.	279.	4
5	75	INTER / 1260.	522.	68.9	.293	11.57	11.7	1.042	224.	586.	5.34	345.	77.	384.	384.	5
6	100	INTER / 1260.	697.	92.0	.422	11.37	11.7	1.025	116.	8104.	6.89	520.	41.	5366.	576.	6
7		IDLE / 400.	0.	.0	.016	3.40	11.7	1.074	199.	106.	.81	135.	17.	24.	54.	7
8	100	RATED / 2100.	564.	124.1	.605	17.68	12.3	1.036	160.	2597.	7.07	525.	85.	2588.	885.	8
9	75	RATED / 2100.	423.	93.1	.493	17.69	11.5	1.031	192.	612.	5.73	295.	103.	628.	510.	9
10	50	RATED / 2100.	282.	62.0	.359	17.86	12.3	1.058	236.	146.	4.19	205.	125.	150.	364.	10
11	25	RATED / 2100.	141.	31.0	.248	18.04	12.3	1.068	260.	106.	2.88	135.	137.	109.	242.	11
12	2	RATED / 2100.	11.	2.4	.156	18.04	12.3	1.077	284.	106.	1.78	85.	149.	110.	155.	12
13		IDLE / 400.	0.	.0	.016	3.40	12.3	1.083	176.	88.	.89	135.	18.	18.	50.	13

MODE	CALCULATED GRAMS/KG-FUEL HC	CALCULATED GRAMS/KG-FUEL CO	CALCULATED GRAMS/KG-FUEL NOX	CALCULATED GRAMS/KW-HR HC	CALCULATED GRAMS/KW-HR CO	CALCULATED GRAMS/KW-HR NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR KG/KW-HR	MODAL WEIGHT FACTOR	MODE
1	22.54	20.21	52.32	******	******	*****	.0047	.0687	.069	.990	.0042	-10.9	.998	*****	.067	1
2	20.93	25.46	26.03	45.61	55.48	56.73	.0056	.0687	.081	.986	.0058	4.1	1.023	2.130	.080	2
3	9.77	9.90	24.01	3.17	3.21	7.79	.0107	.0687	.155	.977	.0107	.7	1.021	.318	.080	3
4	6.16	5.17	23.42	1.60	1.34	6.07	.0174	.0687	.253	.965	.0171	-1.5	1.021	.254	.080	4
5	4.35	21.81	21.83	1.11	5.57	5.58	.0256	.0687	.374	.950	.0254	-1.1	1.021	.250	.080	5
6	1.61	*****	22.75	.44	58.34	6.26	.0375	.0687	.546	.933	.0359	-4.2	1.022	.269	.080	6
7	17.42	25.62	57.16	******	******	*****	.0047	.0687	.069	.990	.0040	-15.6	.998	*****	.067	7
8	2.33	71.34	24.38	.68	20.86	7.13	.0346	.0687	.504	.934	.0341	-1.4	1.070	.273	.080	8
9	3.49	21.25	17.24	1.11	6.75	5.48	.0282	.0687	.410	.947	.0271	-3.7	1.070	.297	.080	9
10	5.81	6.97	16.89	2.02	2.42	5.86	.0203	.0687	.296	.960	.0199	-2.3	1.072	.324	.080	10
11	9.18	7.33	16.28	4.40	3.52	7.81	.0139	.0687	.203	.971	.0138	-.8	1.073	.447	.080	11
12	15.91	11.76	16.56	62.30	46.03	64.85	.0087	.0687	.127	.981	.0086	-1.0	1.074	3.645	.080	12
13	19.42	19.38	52.54	******	******	*****	.0047	.0687	.069	.989	.0044	-7.5	.999	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- = 1.821 GRAM/KW-HR (1.358 GRAM/BHP-HR)
BSCO ------- = 17.682 GRAM/KW-HR (13.191 GRAM/BHP-HR)
BSNOX ------ = 6.990 GRAM/KW-HR (5.215 GRAM/BHP-HR)
BSHC + BSNOX = 8.811 GRAM/KW-HR (6.573 GRAM/BHP-HR)
CORR. BSFC - = .315 KG/KW-HR (.519 LBS/BHP-HR)

TABLE C-10. NOTES CONCERNING TRANSIENT TEST OPERATION OF THE DDAD 6V-71N COACH ENGINE IN BASELINE CONFIGURATION

Cold Start	
C-11	Failed statistical requirements. Power std. error (SE) was 13%, slope (M) was 0.839 and R^2 was 0.7926. Torque SE was 13%, M was .757 and R^2 was 0.7429. Cycle work was 23% below command cycle work of 11.91 hp-hr. Results used for emissions. Bag NOx was 10.82 g/kw-hr.
C-12	Failed statistical requirements. Power slope was 1.084 and torque slope was 1.049. Cycle work was 25% below command cycle work of 11.91 hp-hr. Results used for emissions. Bag NOx was 11.20 g/kw-hr.
Hot Start	
C-13	Failed statistical requirements. Power slope was 1.038 (0.8% too high). Results used for emissions. Bag NOx was 9.46 g/kw-hr.
C-14	Failed statistical requirements. Power slope was 1.062. Torque slope was 1.034. Results used for emissions. Bag NOx was 10.00 g/kw-hr.
C-15	Failed statistical requirements. Power slope was 1.050. Results used for emissions. Bag NOx was 9.92 g/kw-hr.
C-16	Failed statistical requirements. Power slope was 1.075. Torque slope was 1.041. Results used for emissions. Bag NOx was 9.79 g/kw-hr.
Bus Cycle	
C-17	Failed statistical requirements. Power - SE was 10%, M was 0.863, and R^2 was 0.8289. Torque - M was 0.757 and R^2 was 0.7985. Cycle work was 23% below command cycle work of 5.79 hp-hr. Results used for emissions Bag NOx was 10.80 g/kw-hr.
C-18	Failed statistical requirements. Power - SE was 10%, R^2 was 0.8473. Torque slope was 0.802 and R^2 was 0.8180. Cycle work was 23% below command cycle work of 5.79 hp-hr. Results used for emissions. Bag NOx was 11.25 g/kw-hr.

TABLE C-10 (Cont'd). NOTES CONCERNING TRANSIENT TEST OPERATION OF THE DDAD 6V-71N COACH ENGINE IN BASELINE CONFIGURATION

Return to Baseline Cold Start C-19	Failed statistical requirements. Cycle work was 17% below command cycle work of 11.91 hp-hr. Results used only for reference.
Return to Baseline Hot Start C-20	Passed statistical requirements. Results used only for reference.
Return to Baseline Bus Cycle C-21	Failed statistical requirements. Speed slope was 0.5% too high. Cycle work was 20% below command cycle work of 5.79 hp-hr. Results used only for reference.

TABLE C-11. ENGINE EMISSION RESULTS
C-TRANS.

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                                                                                  PROJECT NO. 05-5830-008
ENGINE  NO.D28                             TEST NO.D28-1  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH         DATE  5/13/81
ENGINE  7.0 L(426. CID)                    TIME 10:43                      DIESEL   EM-465-F
CVS NO.  10                                 DYNO NO.  5                     BAG CART NO.  1

BAROMETER 739.14 MM HG(29.10 IN HG)        RELATIVE HUMIDITY ,  ENGINE-48. PCT ,  CVS-70. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)      ABSOLUTE HUMIDITY 10.1 GM/KG( 70.8 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                      1                  2                  3                  4
  DESCRIPTION                                    NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)             274.3 (10.8)       274.3 (10.8)       274.3 (10.8)       274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)           223.5 ( 8.8)       223.5 ( 8.8)       223.5 ( 8.8)       223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)          50.6 (123.0)       50.6 (123.0)       50.6 (123.0)       50.6 (123.0)
  BLOWER REVOLUTIONS                            3326.              3370.              3427.              3337.
  TIME SECONDS                                  296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)           176.5 (  6235.)    178.9 ( 6318.)     181.9 ( 6425.)     177.1 ( 6256.)

  HC  SAMPLE METER/RANGE/PPM                30.1/22/  30.      40.1/22/  40.      95.9/22/  96.      41.3/22/  41.
  HC  BCKGRD METER/RANGE/PPM                11.0/ 2/  11.      13.6/ 2/  14.      12.8/ 2/  13.      13.2/ 2/  13.
  CO  SAMPLE METER/RANGE/PPM                29.6/13/  27.      23.7/13/  22.      56.7/12/ 123.      33.5/13/  31.
  CO  BCKGRD METER/RANGE/PPM                  .3/13/   0.        .3/13/   0.        .3/12/   1.        .5/13/   0.
  CO2 SAMPLE METER/RANGE/PCT                20.6/ 3/  .33      25.9/ 3/  .42      77.9/ 3/ 1.43      22.0/ 3/  .36
  CO2 BCKGRD METER/RANGE/PCT                 2.6/ 3/  .04       2.3/ 3/  .04       2.5/ 3/  .04       2.5/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                11.4/13/  34.      12.2/13/  37.      41.1/13/ 123.      12.8/13/  38.
  NOX BCKGRD METER/RANGE/PPM                  .6/ 2/   1.        .5/ 2/   1.        .1/ 3/   0.        .3/ 2/   0.

  DILUTION FACTOR                              39.71              31.21              9.26              36.93
  HC  CONCENTRATION PPM                        19.                27.               84.                28.
  CO  CONCENTRATION PPM                        26.                21.              116.                30.
  CO2 CONCENTRATION PCT                         .29                .39              1.39                .32
  NOX CONCENTRATION PPM                        33.6               36.2             123.0               38.0

  HC  MASS GRAMS                               1.97               2.78              8.86               2.91
  CO  MASS GRAMS                               5.38               4.32             24.62               6.10
  CO2 MASS GRAMS                              947.6             1275.2            4637.5             1033.4
  NOX MASS GRAMS                              11.34              12.40             42.78              12.86
  FUEL KG (LB)                                 .304 (     .67)     .407 (     .90)   1.484 (    3.27)    .332 (     .73)
  KW HR (HP HR)                                .42 (     .57)      .65 (     .87)    4.84 (    6.49)     .91 (    1.22)

  BSHC G/KW HR (G/HP HR)                      4.65 (    3.46)     4.28 (    3.19)    1.83 (    1.37)    3.19 (    2.38)
  BSCO G/KW HR (G/HP HR)                     12.68 (    9.46)     6.66 (    4.96)    5.09 (    3.79)    6.70 (    5.00)
  BSCO2 G/KW HR (G/HP HR)                  2234.98 (1666.62)  1966.66 (1466.54)  958.49 ( 714.75)  1135.26 ( 846.56)
  BSNOX G/KW HR (G/HP HR)                    26.74 (   19.94)    19.12 (   14.26)    8.84 (    6.59)   14.13 (   10.54)
  BSFC KG/KW HR (LB/HP HR)                    .716 (   1.177)     .628 (   1.032)    .307 (    .504)    .365 (    .599)
TOTAL TEST RESULTS 4 BAGS                           PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          6.82 (   9.15)        90MM FILTER
   BSHC   G/KW HR (G/HP HR)    2.42 (   1.81)            SAMPLE FLOW     SCM(SCF)                   .882 ( 31.13)
   BSCO   G/KW HR (G/HP HR)    5.93 (   4.42)            MULTIPLIER FOR  G/TEST                     .810
   BSCO2  G/KW HR (G/HP HR)   1157. (   863.)            MULTIPLIER FOR  G/KW HR (G/HP HR)          .1188 ( .0886)
   BSNOX  G/KW HR (G/HP HR)   11.64 (   8.68)            MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)      .3208 ( .1455)
   BSFC  KG/KW HR (LB/HP HR)   .370 (   .609)
                                                     20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 0.87 (0.65)                      SAMPLE FLOW     SCM(SCF)                   81.39 (2874.8)
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                                      TABLE C-12. ENGINE EMISSION RESULTS
                                                C-TRANS.                                    PROJECT NO. 05-5830-008

ENGINE   NO.D28                                TEST NO.D28-2  RUN1
ENGINE   MODEL   78 DDAD 6V-71COACH            DATE   5/14/81
ENGINE   7.0 L(426. CID)                       TIME 9:45                      DIESEL   EM-465-F
CVS NO.  10                                     DYNO NO.  5                     BAG CART NO.  1

BAROMETER 743.46 MM HG(29.27 IN HG)            RELATIVE HUMIDITY ,  ENGINE-45. PCT ,  CVS-39. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)          ABSOLUTE HUMIDITY  9.1 GM/KG( 63.8 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                        1                   2                   3                   4
  DESCRIPTION                                     NYNF                LANF                 LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)              274.3 (10.8)        274.3 (10.8)        274.3 (10.8)        274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)            223.5 ( 8.8)        223.5 ( 8.8)        223.5 ( 8.8)        223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)           48.9 (120.0)        48.9 (120.0)        48.9 (120.0)        48.9 (120.0)
  BLOWER REVOLUTIONS                              3326.               3370.               3427.               3336.
  TIME SECONDS                                    296.0               300.0               305.0               297.0
  TOTAL FLOW STD. CU. METRES(SCF)            177.7 (  6275.)    180.0 ( 6358.)      183.0 ( 6465.)      178.2 ( 6294.)

  HC  SAMPLE METER/RANGE/PPM                 27.0/22/  27.       37.1/22/  37.       93.0/22/  93.       38.3/22/  38.
  HC  BCKGRD METER/RANGE/PPM                  9.5/ 2/  10.        8.2/ 2/   8.        8.1/ 2/   8.        8.0/ 2/   8.
  CO  SAMPLE METER/RANGE/PPM                 26.5/13/  24.       21.7/13/  20.       59.8/12/ 131.       28.5/13/  26.
  CO  BCKGRD METER/RANGE/PPM                   .1/13/   0.         .2/13/   0.         .1/12/   0.         .1/13/   0.
  CO2 SAMPLE METER/RANGE/PCT                 20.2/ 3/  .33       26.1/ 3/  .43       77.0/ 3/ 1.41       22.3/ 3/  .36
  CO2 BCKGRD METER/RANGE/PCT                  2.7/ 3/  .04        2.6/ 3/  .04        3.0/ 3/  .05        2.9/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                 10.9/13/  33.       11.8/13/  35.       41.4/13/ 124.       12.3/13/  37.
  NOX BCKGRD METER/RANGE/PPM                   .4/ 2/   0.         .4/ 2/   0.         .2/ 3/   1.         .3/ 2/   0.

  DILUTION FACTOR                               40.59               30.99                9.37               36.48
  HC  CONCENTRATION PPM                         18.                 29.                 86.                 31.
  CO  CONCENTRATION PPM                         24.                 19.                126.                 26.
  CO2 CONCENTRATION PCT                          .28                 .39                1.37                 .32
  NOX CONCENTRATION PPM                         32.3                34.9               123.5                36.5

  HC  MASS GRAMS                                 1.82                3.03                9.05                3.14
  CO  MASS GRAMS                                 4.91                4.02               26.79                5.30
  CO2 MASS GRAMS                               926.5              1280.1              4581.3              1036.9
  NOX MASS GRAMS                                10.98               12.01               43.26               12.44
  FUEL KG (LB)                                  .296 (     .65)     .409 (     .90)    1.467 (    3.23)     .333 (     .73)
  KW HR (HP HR)                                  .39 (     .52)      .64 (     .85)     4.80 (    6.44)      .87 (    1.17)

  BSHC G/KW HR (G/HP HR)                        4.71 (    3.51)     4.76 (    3.55)     1.89 (    1.41)     3.59 (    2.68)
  BSCO G/KW HR (G/HP HR)                       12.70 (    9.47)     6.33 (    4.72)     5.58 (    4.16)     6.08 (    4.53)
  BSCO2 G/KW HR (G/HP HR)                    2396.66 (1787.19)  2012.91 (1501.03)   954.26 ( 711.59)  1187.93 ( 885.84)
  BSNOX G/KW HR (G/HP HR)                      28.40 (   21.18)    18.89 (   14.09)     9.01 (    6.72)    14.26 (   10.63)
  BSFC KG/KW HR (LB/HP HR)                      .767 (   1.261)     .643 (   1.057)     .306 (    .502)     .381 (    .627)

TOTAL TEST RESULTS 4 BAGS                             PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          6.70 (   8.98)            90MM FILTER
  BSHC   G/KW HR (G/HP HR)     2.54 (   1.90)              SAMPLE FLOW      SCM(SCF)                 .949 ( 33.52)
  BSCO   G/KW HR (G/HP HR)     6.13 (   4.57)              MULTIPLIER FOR   G/TEST                   .757
  BSCO2  G/KW HR (G/HP HR)  1169. (   871.)              MULTIPLIER FOR   G/KW HR (G/HP HR)        .1131 ( .0844)
  BSNOX  G/KW HR (G/HP HR)    11.75 (   8.76)              MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)    .3023 ( .1371)
  BSFC  KG/KW HR (LB/HP HR)    .374 (   .615)
                                                         20 X 20 FILTERS
                                                           SAMPLE FLOW      SCM(SCF)                 80.47 (2842.2)

PART.G/KW-HR (G/HP-HR) 0.85 (0.63)
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                                   TABLE C-13. ENGINE EMISSION RESULTS
                                                 H-TRANS.                                    PROJECT NO. 05-5830-008

ENGINE   NO.D28                                 TEST NO.D28-1  RUN1
ENGINE   MODEL    78 DDAD 6V-71COACH            DATE  5/13/81
ENGINE   7.0 L(426. CID)                        TIME 11:25                          DIESEL    EM-465-F
CVS NO.  10                                      DYNO NO.  5                          BAG CART NO.  1

BAROMETER 738.89 MM HG(29.09 IN HG)             RELATIVE HUMIDITY ,  ENGINE-49. PCT ,  CVS-62. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)           ABSOLUTE HUMIDITY 10.3 GM/KG( 72.4 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                          1                  2                   3                   4
  DESCRIPTION                                        NYNF               LANF                LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)                 274.3 (10.8)       274.3 (10.8)        274.3 (10.8)        274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)               223.5 ( 8.8)       223.5 ( 8.8)        223.5 ( 8.8)        223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)              48.9 (120.0)       48.9 (120.0)        48.9 (120.0)        48.9 (120.0)
  BLOWER REVOLUTIONS                                3326.              3370.               3427.               3336.
  TIME SECONDS                                      296.0              299.9               305.0               297.0
  TOTAL FLOW STD. CU. METRES(SCF)               177.0 (  6250.)    179.3 ( 6333.)      182.3 ( 6440.)      177.5 ( 6269.)

  HC  SAMPLE METER/RANGE/PPM                    39.7/22/  40.       53.1/22/  53.       99.3/22/  99.       43.3/22/  43.
  HC  BCKGRD METER/RANGE/PPM                    15.5/ 2/  16.       14.0/ 2/  14.       13.2/ 2/  13.       12.8/ 2/  13.
  CO  SAMPLE METER/RANGE/PPM                    30.4/13/  28.       57.7/13/  55.       69.2/12/ 157.       37.4/13/  35.
  CO  BCKGRD METER/RANGE/PPM                      .3/13/   0.         .4/13/   0.         .3/12/   1.         .6/13/   1.
  CO2 SAMPLE METER/RANGE/PCT                    20.7/ 3/  .33       30.3/ 3/  .50       76.2/ 3/ 1.39       22.0/ 3/  .36
  CO2 BCKGRD METER/RANGE/PCT                     2.7/ 3/  .04        2.5/ 3/  .04        2.5/ 3/  .04        2.8/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                    11.2/13/  34.       11.9/13/  36.       40.6/13/ 122.       12.6/13/  38.
  NOX BCKGRD METER/RANGE/PPM                      .3/ 2/   0.         .4/ 2/   0.         .2/ 3/   1.         .5/ 2/   1.

  DILUTION FACTOR                                   39.38              26.19               9.46               36.87
  HC  CONCENTRATION PPM                             25.                40.                 88.                31.
  CO  CONCENTRATION PPM                             27.                53.                149.                33.
  CO2 CONCENTRATION PCT                             .29                .46                 1.36               .31
  NOX CONCENTRATION PPM                             33.3               35.3               121.3               37.3

  HC  MASS GRAMS                                    2.51               4.10                9.21               3.16
  CO  MASS GRAMS                                    5.56              11.09               31.66               6.87
  CO2 MASS GRAMS                                   950.5             1524.4              4531.2              1021.0
  NOX MASS GRAMS                                   11.26              12.12               42.30              12.68
  FUEL KG (LB)                                     .305 (     .67)    .490 (    1.08)    1.454 (    3.21)    .329 (     .72)
  KW HR (HP HR)                                    1.00 (    1.34)    1.42 (    1.91)     5.13 (    6.87)     .92 (    1.24)

  BSHC G/KW HR (G/HP HR)                           2.52 (    1.88)    2.88 (    2.15)     1.80 (    1.34)    3.43 (    2.56)
  BSCO G/KW HR (G/HP HR)                           5.57 (    4.15)    7.80 (    5.82)     6.18 (    4.61)    7.44 (    5.55)
  BSCO2 G/KW HR (G/HP HR)                        952.82 (  710.52) 1072.36 (  799.66)   884.12 (  659.29) 1106.44 (  825.07)
  BSNOX G/KW HR (G/HP HR)                         11.29 (    8.42)    8.53 (    6.36)     8.25 (    6.15)   13.74 (   10.24)
  BSFC KG/KW HR (LB/HP HR)                        .306 (    .503)    .345 (    .567)     .284 (    .466)    .356 (    .585)
TOTAL TEST RESULTS 4 BAGS                          PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.47 ( 11.35)          90MM FILTER
  BSHC   G/KW HR (G/HP HR)     2.24 (  1.67)              SAMPLE FLOW      SCM(SCF)               .935 ( 33.02)
  BSCO   G/KW HR (G/HP HR)     6.52 (  4.86)              MULTIPLIER FOR   G/TEST                 .766
  BSCO2  G/KW HR (G/HP HR)     948. (  707.)              MULTIPLIER FOR   G/KW HR (G/HP HR)      .0905 ( .0675)
  BSNOX  G/KW HR (G/HP HR)     9.25 (  6.90)              MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)  .2971 ( .1348)
  BSFC  KG/KW HR (LB/HP HR)    .304 (  .501)
                                                       20 X 20 FILTERS
                                                          SAMPLE FLOW     SCM(SCF)                81.84 (2890.5)
PART. G/KW-HR (G/HP-HR) 0.70 (0.52)
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TABLE C-14. ENGINE EMISSION RESULTS
H-TRANS.

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                                                                                          PROJECT NO. 05-5830-008

ENGINE   NO.D28                            TEST NO.D28-2  RUN1
ENGINE   MODEL    78 DDAD 6V-71COACH       DATE  5/14/81
ENGINE   7.0 L(426. CID)                   TIME 10:25                        DIESEL    EM-465-F
CVS NO.  10                                  DYNO NO.  5                       BAG CART NO.  1

BAROMETER 743.71 MM HG(29.28 IN HG)        RELATIVE HUMIDITY ,  ENGINE-49. PCT ,  CVS-41. PCT
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)      ABSOLUTE HUMIDITY  9.8 GM/KG( 68.8 GRAINS/LB)       NOX HUMIDITY C.F. 1.0000

BAG RESULTS
   BAG NUMBER                                    1                 2                  3                  4
   DESCRIPTION                                  NYNF              LANF               LAF                NYNF
   BLOWER DIF P MM. H2O(IN. H2O)            274.3 (10.8)      274.3 (10.8)       274.3 (10.8)       274.3 (10.8)
   BLOWER INLET P MM. H2O(IN. H2O)          223.5 ( 8.8)      223.5 ( 8.8)       223.5 ( 8.8)       223.5 ( 8.8)
   BLOWER INLET TEMP. DEG. C(DEG. F)         48.9 (120.0)      48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
   BLOWER REVOLUTIONS                         3326.             3370.              3427.              3336.
   TIME SECONDS                              296.0             300.0              305.0              297.0
   TOTAL FLOW STD. CU. METRES(SCF)        177.7 (   6275.)  180.0 ( 6358.)     183.0 ( 6465.)     178.2 ( 6294.)

   HC  SAMPLE METER/RANGE/PPM             35.1/22/  35.      48.6/22/  49.      96.4/22/  96.      40.3/22/  40.
   HC  BCKGRD METER/RANGE/PPM              7.6/ 2/   8.       8.2/ 2/   8.       7.3/ 2/   7.       7.0/ 2/   7.
   CO  SAMPLE METER/RANGE/PPM             30.4/13/  28.      51.3/13/  48.      50.8/12/ 108.      38.7/13/  36.
   CO  BCKGRD METER/RANGE/PPM               .4/13/   0.        .3/13/   0.        .3/12/   1.        .6/13/   1.
   CO2 SAMPLE METER/RANGE/PCT             21.4/ 3/  .35      33.1/ 3/  .55      73.6/ 3/ 1.34      22.0/ 3/  .36
   CO2 BCKGRD METER/RANGE/PCT              3.1/ 3/  .05       3.4/ 3/  .05       2.9/ 3/  .04       2.6/ 3/  .04
   NOX SAMPLE METER/RANGE/PPM             12.1/13/  36.      15.8/13/  47.      41.9/13/ 126.       9.8/13/  30.
   NOX BCKGRD METER/RANGE/PPM               .2/ 2/   0.        .3/ 3/   1.        .2/ 3/   1.        .2/ 2/   0.

   DILUTION FACTOR                           38.10              23.89               9.87              36.88
   HC  CONCENTRATION PPM                     28.                41.                90.                33.
   CO  CONCENTRATION PPM                     27.                47.               103.                35.
   CO2 CONCENTRATION PCT                       .30                .50               1.30                .32
   NOX CONCENTRATION PPM                     36.1               46.5              125.2               29.3

   HC  MASS GRAMS                             2.84               4.23               9.48               3.44
   CO  MASS GRAMS                             5.60               9.87              22.00               7.20
   CO2 MASS GRAMS                           973.7             1652.7             4350.7             1034.8
   NOX MASS GRAMS                            12.28              16.02              43.85              10.00
   FUEL KG (LB)                               .313 (    .69)     .530 (   1.17)    1.393 (   3.07)     .333 (    .74)
   KW HR (HP HR)                              .89 (   1.19)     1.40 (   1.87)     4.95 (   6.64)      .90 (   1.20)

   BSHC G/KW HR (G/HP HR)                    3.20 (   2.39)     3.03 (   2.26)     1.92 (   1.43)     3.83 (   2.86)
   BSCO G/KW HR (G/HP HR)                    6.32 (   4.71)     7.07 (   5.27)     4.44 (   3.31)     8.02 (   5.98)
   BSCO2 G/KW HR (G/HP HR)                1099.75 ( 820.09)  1183.35 ( 882.43)   878.83 ( 655.35)  1152.53 ( 859.44)
   BSNOX G/KW HR (G/HP HR)                  13.87 (  10.35)    11.47 (   8.55)     8.86 (   6.61)    11.14 (   8.30)
   BSFC KG/KW HR (LB/HP HR)                  .353 (   .581)     .380 (   .624)     .281 (   .462)     .371 (   .610)

TOTAL TEST RESULTS 4 BAGS                            PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.13 ( 10.90)          90MM FILTER
   BSHC   G/KW HR (G/HP HR)    2.46 (  1.83)              SAMPLE FLOW     SCM(SCF)                  .929 ( 32.80)
   BSCO   G/KW HR (G/HP HR)    5.49 (  4.10)              MULTIPLIER FOR  G/TEST                    .774
   BSCO2  G/KW HR (G/HP HR)    985. (  735.)              MULTIPLIER FOR  G/KW HR (G/HP HR)         .0952 ( .0710)
   BSNOX  G/KW HR (G/HP HR)   10.10 (  7.53)              MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)     .3013 ( .1367)
   BSFC  KG/KW HR (LB/HP HR)   .316 (  .519)
                                                      20 X 20 FILTERS
                                                          SAMPLE FLOW    SCM(SCF)                  80.26 (2834.7)

PART. G/KW-HR (G/HP-HR) 0.71 (0.53)
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                                        TABLE C-15. ENGINE EMISSION RESULTS
                                                    H-TRANS.                                      PROJECT NO. 05-5830-008

ENGINE  NO.D28                                 TEST NO.D28-3  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH             DATE  5/14/81
ENGINE  7.0 L(426. CID)                        TIME 11:10                         DIESEL   EM-465-F
CVS NO.  10                                     DYNO NO.  5                        BAG CART NO.  1

BAROMETER 743.97 MM HG(29.29 IN HG)            RELATIVE HUMIDITY ,  ENGINE-38. PCT ,  CVS-39. PCT
DRY BULB TEMP. 28.9 DEG C(84.0 DEG F)          ABSOLUTE HUMIDITY  9.7 GM/KG( 67.7 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                    1                2                 3                  4
  DESCRIPTION                                 NYNF             LANF               LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)           274.3 (10.8)     274.3 (10.8)      274.3 (10.8)      274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)         223.5 ( 8.8)     223.5 ( 8.8)      223.5 ( 8.8)      223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)        48.9 (120.0)     48.9 (120.0)      48.9 (120.0)      48.9 (120.0)
  BLOWER REVOLUTIONS                         3326.            3370.             3427.             3337.
  TIME SECONDS                               296.0            299.9             305.0             297.0
  TOTAL FLOW STD. CU. METRES(SCF)         177.5 (   6270.)  179.9 ( 6352.)    182.9 ( 6460.)    178.1 ( 6290.)

  HC  SAMPLE METER/RANGE/PPM               7.3/23/  36.     10.2/23/  51.     20.2/23/ 101.      8.3/23/  42.
  HC  BCKGRD METER/RANGE/PPM               7.0/ 2/   7.      7.6/ 2/   8.      7.3/ 2/   7.      7.0/ 2/   7.
  CO  SAMPLE METER/RANGE/PPM              33.1/13/  31.     51.9/13/  49.     54.6/12/ 117.     32.4/13/  30.
  CO  BCKGRD METER/RANGE/PPM                .6/13/   1.       .6/13/   1.       .4/12/   1.       .5/13/   0.
  CO2 SAMPLE METER/RANGE/PCT              21.5/ 3/  .35     31.8/ 3/  .53     75.2/ 3/ 1.37     22.1/ 3/  .36
  CO2 BCKGRD METER/RANGE/PCT               2.6/ 3/  .04      2.7/ 3/  .04      2.7/ 3/  .04      2.8/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM              11.7/13/  35.     15.6/13/  47.     41.7/13/ 125.     12.2/13/  37.
  NOX BCKGRD METER/RANGE/PPM                .7/ 2/   1.       .6/ 2/   1.       .1/ 3/   0.       .4/ 2/   0.

  DILUTION FACTOR                             37.87            24.92              9.63             36.76
  HC  CONCENTRATION PPM                       30.              44.               94.               35.
  CO  CONCENTRATION PPM                       29.              47.              112.               29.
  CO2 CONCENTRATION PCT                       .31              .49              1.33               .32
  NOX CONCENTRATION PPM                      34.3             46.2             124.8              36.3

  HC  MASS GRAMS                             3.04             4.55              9.97              3.58
  CO  MASS GRAMS                             6.08             9.94             23.90              5.98
  CO2 MASS GRAMS                           1002.9           1608.1            4466.9            1030.1
  NOX MASS GRAMS                            11.66            15.91             43.66             12.35
  FUEL KG (LB)                             .322 (    .71)  .517 (    1.14)  1.431 (    3.15)   .331 (     .73)
  KW HR (HP HR)                             .90 (   1.20)  1.41 (    1.89)   4.94 (    6.62)    .89 (    1.19)

  BSHC G/KW HR (G/HP HR)                   3.38 (   2.52)  3.23 (    2.41)   2.02 (    1.51)   4.05 (    3.02)
  BSCO G/KW HR (G/HP HR)                   6.77 (   5.05)  7.06 (    5.26)   4.84 (    3.61)   6.76 (    5.04)
  BSCO2 G/KW HR (G/HP HR)               1117.01 ( 832.96) 1141.23 ( 851.02) 904.58 ( 674.54) 1163.43 ( 867.57)
  BSNOX G/KW HR (G/HP HR)                 12.99 (   9.69) 11.29 (    8.42)   8.84 (    6.59)  13.95 (   10.41)
  BSFC KG/KW HR (LB/HP HR)                 .359 (   .590)  .367 (    .603)   .290 (    .476)   .374 (    .615)

TOTAL TEST RESULTS 4 BAGS                         PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.13 ( 10.90)          90MM FILTER
  BSHC    G/KW HR (G/HP HR)    2.60 (  1.94)              SAMPLE FLOW      SCM(SCF)                .925 ( 32.68)
  BSCO    G/KW HR (G/HP HR)    5.65 (  4.21)              MULTIPLIER FOR   G/TEST                  .776
  BSCO2   G/KW HR (G/HP HR)    997. (  744.)              MULTIPLIER FOR   G/KW HR (G/HP HR)       .0955 ( .0712)
  BSNOX   G/KW HR (G/HP HR)   10.28 (  7.67)              MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)   .2984 ( .1354)
  BSFC   KG/KW HR (LB/HP HR)   .320 (  .526)
                                                      20 X 20 FILTERS
                                                         SAMPLE FLOW     SCM(SCF)                 79.45 (2806.1)
PART. G/KW-HR (G/HP-HR) 0.71 (0.53)
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                              TABLE C-16. ENGINE EMISSION RESULTS
                                           H-TRANS.                                          PROJECT NO. 05-5830-008
ENGINE   NO.D28                                TEST NO.D28-4  RUN1
ENGINE   MODEL    78 DDAD 6V 71COACH           DATE  5/14/81
ENGINE   7.0 L(426. CID)                       TIME 11:50                         DIESEL   EM-465-F
CVS NO.   10                                    DYNO NO.  5                        BAG CART NO.  1

BAROMETER 744.22 MM HG(29.30 IN HG)            RELATIVE HUMIDITY ,  ENGINE-38. PCT ,  CVS-38. PCT
DRY BULB TEMP. 28.3 DEG C(83.0 DEG F)          ABSOLUTE HUMIDITY  9.4 GM/KG( 65.5 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                         1                  2                  3                  4
  DESCRIPTION                                      NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)               274.3 (10.8)      274.3 (10.8)      274.3 (10.8)      274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)             223.5 ( 8.8)      223.5 ( 8.8)      223.5 ( 8.8)      223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)            48.9 (120.0)      48.9 (120.0)      48.9 (120.0)      48.9 (120.0)
  BLOWER REVOLUTIONS                              3326.             3370.             3427.             3336.
  TIME SECONDS                                    296.0             299.9             305.0             297.0
  TOTAL FLOW STD. CU. METRES(SCF)             177.5 (  6270.)   179.9 ( 6353.)    182.9 ( 6461.)    178.1 ( 6289.)

  HC   SAMPLE METER/RANGE/PPM                  7.5/23/  37.     10.2/23/  51.     20.3/23/ 102.      8.4/23/  42.
  HC   BCKGRD METER/RANGE/PPM                  7.7/ 2/   8.      8.0/ 2/   8.      7.3/ 2/   7.      6.9/ 2/   7.
  CO   SAMPLE METER/RANGE/PPM                 36.1/13/  33.     51.9/13/  49.     55.0/12/ 118.     35.5/13/  33.
  CO   BCKGRD METER/RANGE/PPM                   .6/13/   1.       .6/13/   1.       .4/12/   1.       .9/13/   1.
  CO2  SAMPLE METER/RANGE/PCT                 21.8/ 3/  .35     31.8/ 3/  .53     73.9/ 3/ 1.34     22.1/ 3/  .36
  CO2  BCKGRD METER/RANGE/PCT                  2.8/ 3/  .04      2.9/ 3/  .04      3.0/ 3/  .05      2.6/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM                 11.9/13/  36.     15.6/13/  47.     41.5/13/ 125.     13.0/13/  39.
  NOX  BCKGRD METER/RANGE/PPM                   .4/ 2/   0.       .4/ 2/   0.       .2/ 3/   1.       .3/ 2/   0.

  DILUTION FACTOR                                 37.29             24.92              9.81             36.72
  HC   CONCENTRATION PPM                          30.               43.                95.               35.
  CO   CONCENTRATION PPM                          32.               47.               113.               31.
  CO2  CONCENTRATION PCT                          .31               .49               1.30              .32
  NOX  CONCENTRATION PPM                          35.4              46.4             124.1              38.7

  HC   MASS GRAMS                                 3.07              4.51              10.02              3.64
  CO   MASS GRAMS                                 6.67              9.95              24.14              6.52
  CO2  MASS GRAMS                              1010.0            1598.5             4363.7             1039.7
  NOX  MASS GRAMS                                12.01             15.98              43.42             13.18
  FUEL KG (LB)                                 .325 (    .72)    .514 (   1.13)    1.398 (   3.08)    .335 (    .74)
  KW HR (HP HR)                                 .91 (   1.22)    1.43 (   1.92)     5.01 (   6.72)     .89 (   1.19)

  BSHC G/KW HR (G/HP HR)                       3.37 (   2.51)    3.14 (   2.34)     2.00 (   1.49)    4.11 (   3.07)
  BSCO G/KW HR (G/HP HR)                       7.33 (   5.46)    6.94 (   5.17)     4.81 (   3.59)    7.36 (   5.49)
  BSCO2 G/KW HR (G/HP HR)                   1109.51 ( 827.37) 1114.70 ( 831.23)   870.49 ( 649.13) 1174.27 ( 875.65)
  BSNOX G/KW HR (G/HP HR)                     13.19 (   9.84)   11.14 (   8.31)     8.66 (   6.46)   14.88 (  11.10)
  BSFC KG/KW HR (LB/HP HR)                     .357 (   .587)    .358 (   .589)     .279 (   .459)    .378 (   .622)

TOTAL TEST RESULTS 4 BAGS                              PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.24 ( 11.05)             90MM FILTER
   BSHC    G/KW HR (G/HP HR)   2.58 (  1.92)                SAMPLE FLOW      SCM(SCF)                  .930 ( 32.84)
   BSCO    G/KW HR (G/HP HR)   5.74 (  4.28)                MULTIPLIER FOR   G/TEST                    .773
   BSCO2   G/KW HR (G/HP HR)   972. (  725.)                MULTIPLIER FOR   G/KW HR (G/HP HR)         .0937 ( .0699)
   BSNOX   G/KW HR (G/HP HR)  10.26 (  7.65)                MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)     .3004 ( .1363)
   BSFC   KG/KW HR (LB/HP HR)  .312 (  .513)
                                                         20 X 20 FILTERS
                                                           SAMPLE FLOW     SCM(SCF)                  79.28 (2800.2)

PART . G/KW-HR (G/HP-HR) 0.68 (0.51)
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                                    TABLE C.17. ENGINE EMISSION RESULTS
                                                   H-TRANS.                               PROJECT NO. 05-5830-008

ENGINE  NO.D28                              TEST NO.D28-1  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH          DATE  5/13/81
ENGINE  7.0 L(426. CID)                     TIME 1:50                      DIESEL   EM-465-F
CVS NO.  10                                   DYNO NO.  5                    BAG CART NO.  1

BAROMETER 738.38 MM HG(29.07 IN HG)         RELATIVE HUMIDITY , ENGINE-40. PCT , CVS-60. PCT
DRY BULB TEMP. 28.3 DEG C(83.0 DEG F)       ABSOLUTE HUMIDITY  9.8 GM/KG( 68.7 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                      1                   2                   3
  BLOWER DIF P MM. H2O(IN. H2O)            274.3 (10.8)        274.3 (10.8)        269.2 (10.6)
  BLOWER INLET P MM. H2O(IN. H2O)          223.5 ( 8.8)        223.5 ( 8.8)        223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)         48.9 (120.0)        48.9 (120.0)        48.9 (120.0)
  BLOWER REVOLUTIONS                          3066.               3235.               3067.
  TIME SECONDS                                272.9               287.9               273.0
  TOTAL FLOW STD. CU. METRES(SCF)          162.4 (   5734.)   171.3 ( 6050.)      162.5 ( 5740.)

  HC  SAMPLE METER/RANGE/PPM               43.1/22/  43.       45.3/22/  45.       44.5/22/  44.
  HC  BCKGRD METER/RANGE/PPM               13.3/ 2/  13.       12.9/ 2/  13.       13.9/ 2/  14.
  CO  SAMPLE METER/RANGE/PPM               19.6/13/  18.       51.6/13/  49.       20.5/13/  19.
  CO  BCKGRD METER/RANGE/PPM                1.1/13/   1.        1.1/13/   1.        1.2/13/   1.
  CO2 SAMPLE METER/RANGE/PCT               23.9/ 3/  .39       30.2/ 3/  .50       23.8/ 3/  .39
  CO2 BCKGRD METER/RANGE/PCT                2.8/ 3/  .04        2.4/ 3/  .04        2.5/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM               10.4/13/  31.       15.4/13/  46.       11.0/13/  33.
  NOX BCKGRD METER/RANGE/PPM                 .7/ 2/   1.         .9/ 2/   1.        1.2/ 2/   1.

  DILUTION FACTOR                             33.96               26.35               34.09
  HC  CONCENTRATION PPM                       30.                 33.                 31.
  CO  CONCENTRATION PPM                       16.                 46.                 17.
  CO2 CONCENTRATION PCT                        .35                 .46                 .35
  NOX CONCENTRATION PPM                       30.7                45.4                31.9

  HC  MASS GRAMS                              2.83                3.25                2.90
  CO  MASS GRAMS                              3.10                9.27                3.24
  CO2 MASS GRAMS                            1031.5              1455.5              1040.7
  NOX MASS GRAMS                              9.52               14.86                9.92
  FUEL KG (LB)                               .330 (     .73)     .467 (    1.03)     .333 (     .73)
  KW HR (HP HR)                               .89 (    1.19)     1.50 (    2.01)      .95 (    1.27)

  BSHC G/KW HR (G/HP HR)                     3.19 (    2.38)     2.17 (    1.62)     3.06 (    2.28)
  BSCO G/KW HR (G/HP HR)                     3.50 (    2.61)     6.19 (    4.62)     3.42 (    2.55)
  BSCO2 G/KW HR (G/HP HR)                 1165.11 (  868.82)   972.65 (  725.31)  1098.16 (  818.90)
  BSNOX G/KW HR (G/HP HR)                   10.76 (    8.02)     9.93 (    7.41)    10.47 (    7.80)
  BSFC KG/KW HR (LB/HP HR)                   .372 (    .612)     .312 (    .513)     .351 (    .577)

TOTAL TEST RESULTS 3 BAGS                        PARTICULATE DATA, TOTAL FOR 3 BAGS

  TOTAL KW HR (HP HR)            3.33 (   4.46)      90MM FILTER
  BSHC    G/KW HR (G/HP HR)      2.70 (   2.01)         SAMPLE FLOW      SCM(SCF)                  .597 ( 21.09)
  BSCO    G/KW HR (G/HP HR)      4.69 (   3.50)         MULTIPLIER FOR   G/TEST                    .831
  BSCO2   G/KW HR (G/HP HR)     1060. (   790.)         MULTIPLIER FOR   G/KW HR (G/HP HR)         .2495 ( .1861)
  BSNOX   G/KW HR (G/HP HR)     10.30 (   7.68)         MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)     .7356 ( .3337)
  BSFC    KG/KW HR (LB/HP HR)    .339 (   .558)
                                                     20 X 20 FILTERS
                                                        SAMPLE FLOW      SCM(SCF)                  54.99 (1942.1)

PART. G/KW-HR (G/HP-HR) 0.76 (0.57)
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TABLE C-18. ENGINE EMISSION RESULTS
H-TRANS.

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                                                                                    PROJECT NO. 05-5830-008

ENGINE  NO.D28                              TEST NO.D28-2  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH          DATE  5/13/81
ENGINE  7.0 L(426. CID)                     TIME 2:30                       DIESEL   EM-465-F
CVS NO.  10                                  DYNO NO.  5                     BAG CART NO.  1

BAROMETER 737.87 MM HG(29.05 IN HG)         RELATIVE HUMIDITY ,  ENGINE-44. PCT ,  CVS-57. PCT
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)       ABSOLUTE HUMIDITY  9.9 GM/KG( 69.4 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                       1                  2                   3
  BLOWER DIF P MM. H2O(IN. H2O)              274.3 (10.8)       274.3 (10.8)        274.3 (10.8)
  BLOWER INLET P MM. H2O(IN. H2O)            223.5 ( 8.8)       223.5 ( 8.8)        223.5 ( 8.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)           50.0 (122.0)       48.9 (120.0)        48.9 (120.0)
  BLOWER REVOLUTIONS                            3066.              3235.               3067.
  TIME SECONDS                                  272.9              288.0               273.0
  TOTAL FLOW STD. CU. METRES(SCF)            161.9 (   5720.)   171.1 ( 6043.)      162.2 ( 5729.)

  HC  SAMPLE METER/RANGE/PPM                 43.5/22/  43.      45.5/22/  46.       44.3/22/  44.
  HC  BCKGRD METER/RANGE/PPM                 13.0/ 2/  13.      13.0/ 2/  13.       13.0/ 2/  13.
  CO  SAMPLE METER/RANGE/PPM                 20.6/13/  19.      49.4/13/  47.       19.0/13/  17.
  CO  BCKGRD METER/RANGE/PPM                   .8/13/   1.        .9/13/   1.        1.0/13/   1.
  CO2 SAMPLE METER/RANGE/PCT                 23.8/ 3/  .39      29.6/ 3/  .49       23.8/ 3/  .39
  CO2 BCKGRD METER/RANGE/PCT                  2.7/ 3/  .04       2.6/ 3/  .04        2.4/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM                 10.6/13/  32.      15.6/13/  47.       10.9/13/  33.
  NOX BCKGRD METER/RANGE/PPM                  1.5/ 2/   2.       1.6/ 2/   2.        1.4/ 2/   1.

  DILUTION FACTOR                               34.10              26.93               34.11
  HC  CONCENTRATION PPM                         31.                33.                 32.
  CO  CONCENTRATION PPM                         18.                45.                 16.
  CO2 CONCENTRATION PCT                         .35                .45                 .35
  NOX CONCENTRATION PPM                         30.2               45.1                31.4

  HC  MASS GRAMS                                2.88               3.25                2.96
  CO  MASS GRAMS                                3.32               8.87                3.02
  CO2 MASS GRAMS                             1028.2             1410.9              1043.2
  NOX MASS GRAMS                                9.36              14.76                9.74
  FUEL KG (LB)                                .329 (    .72)     .453 (   1.00)      .334 (    .74)
  KW HR (HP HR)                                .90 (   1.20)     1.48 (   1.99)       .92 (   1.24)

  BSHC G/KW HR (G/HP HR)                      3.21 (   2.39)     2.19 (   1.64)      3.21 (   2.40)
  BSCO G/KW HR (G/HP HR)                      3.69 (   2.75)     5.98 (   4.46)      3.27 (   2.44)
  BSCO2 G/KW HR (G/HP HR)                  1145.24 ( 854.01)   950.77 ( 708.99)   1130.56 ( 843.05)
  BSNOX G/KW HR (G/HP HR)                    10.42 (   7.77)     9.95 (   7.42)     10.56 (   7.87)
  BSFC KG/KW HR (LB/HP HR)                    .366 (   .602)     .305 (   .501)      .361 (   .594)

TOTAL TEST RESULTS 3 BAGS                       PARTICULATE DATA, TOTAL FOR 3 BAGS

 TOTAL KW HR (HP HR)         3.30 (   4.43)        90MM FILTER
  BSHC   G/KW HR (G/HP HR)   2.75 (   2.05)           SAMPLE FLOW      SCM(SCF)                .652 ( 23.02)
  BSCO   G/KW HR (G/HP HR)   4.60 (   3.43)           MULTIPLIER FOR   G/TEST                  .760
  BSCO2  G/KW HR (G/HP HR)   1054. (  786.)           MULTIPLIER FOR   G/KW HR (G/HP HR)       .2300 ( .1715)
  BSNOX  G/KW HR (G/HP HR)   10.25 (   7.64)          MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)   .6816 ( .3092)
  BSFC  KG/KW HR (LB/HP HR)   .337 (   .555)
                                                   20 X 20 FILTERS
                                                      SAMPLE FLOW      SCM(SCF)               54.65 (1930.1)

PART. G/KW-HR (G/HP-HR) 0.90 (0.67)
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                                  TABLE C-19. ENGINE EMISSION RESULTS                          PROJECT NO. 05-5830-008
                                               C-TRANS
ENGINE  NO.D28                          TEST NO.D28-4  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH      DATE  6/10/81
ENGINE  7.0 L(426. CID)                 TIME 10:15                               DIESEL   EM-465-F
CVS NO.  10                               DYNO NO.  5                              BAG CART NO.  1

BAROMETER 735.58 MM HG(28.96 IN HG)     RELATIVE HUMIDITY ,  ENGINE-66. PCT ,  CVS-57. PCT
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)   ABSOLUTE HUMIDITY 15.0 GM/KG(105.3 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                    2                    3                    4
  DESCRIPTION                               NYNF                 LANF                 LAF                  NYNF
  BLOWER DIF P MM. H2O(IN. H2O)          215.9 ( 8.5)         215.9 ( 8.5)         215.9 ( 8.5)         215.9 ( 8.5)
  BLOWER INLET P MM. H2O(IN. H2O)        165.1 ( 6.5)         165.1 ( 6.5)         165.1 ( 6.5)         165.1 ( 6.5)
  BLOWER INLET TEMP. DEG. C(DEG. F)       48.9 (120.0)         48.9 (120.0)         48.9 (120.0)         48.9 (120.0)
  BLOWER REVOLUTIONS                       3337.                3371.                3428.                3337.
  TIME SECONDS                             297.0                300.0                305.0                297.0
  TOTAL FLOW STD. CU. METRES(SCF)        158.8 (  5610.)      160.5 ( 5667.)       163.2 ( 5763.)       158.8 ( 5610.)

  HC  SAMPLE METER/RANGE/PPM             4.9/23/  24.          7.7/23/  39.        16.4/23/  82.         8.6/23/  43.
  HC  BCKGRD METER/RANGE/PPM             6.2/ 2/   6.          8.8/ 2/   9.        10.1/ 2/  10.        11.5/ 2/  12.
  CO  SAMPLE METER/RANGE/PPM            33.2/13/  31.         29.3/13/  27.        52.3/12/ 112.        42.2/13/  39.
  CO  BCKGRD METER/RANGE/PPM              .1/13/   0.           .1/13/   0.          .4/12/   1.         1.1/13/   1.
  CO2 SAMPLE METER/RANGE/PCT            25.9/ 3/  .42         36.2/ 3/  .61        83.6/ 3/ 1.54        25.4/ 3/  .41
  CO2 BCKGRD METER/RANGE/PCT             3.2/ 3/  .05          3.5/ 3/  .05         3.9/ 3/  .06         4.0/ 3/  .06
  NOX SAMPLE METER/RANGE/PPM            12.4/13/  37.         14.6/13/  44.        37.9/13/ 114.        12.6/13/  38.
  NOX BCKGRD METER/RANGE/PPM              .7/ 2/   1.           .6/ 2/   1.          .4/ 3/   1.         1.2/ 2/   1.

  DILUTION FACTOR                          31.26                21.82                 8.57                31.70
  HC  CONCENTRATION PPM                    18.                  30.                  73.                  32.
  CO  CONCENTRATION PPM                    30.                  26.                 106.                  37.
  CO2 CONCENTRATION PCT                     .38                  .56                 1.49                  .36
  NOX CONCENTRATION PPM                    36.6                 43.3                112.7                 36.7

  HC  MASS GRAMS                            1.69                 2.80                 6.87                 2.93
  CO  MASS GRAMS                            5.50                 4.86                20.07                 6.92
  CO2 MASS GRAMS                         1093.3               1635.1               4457.3               1032.9
  NOX MASS GRAMS                           11.11                13.31                35.17                11.14
  FUEL KG (LB)                              .349 (     .77)      .521 (    1.15)     1.423 (    3.14)      .332 (     .73)
  KW HR (HP HR)                             .76 (    1.02)      1.08 (    1.45)      4.65 (    6.24)       .91 (    1.22)

  BSHC G/KW HR (G/HP HR)                   2.23 (    1.66)      2.58 (    1.92)      1.48 (    1.10)      3.22 (    2.40)
  BSCO G/KW HR (G/HP HR)                   7.23 (    5.39)      4.48 (    3.34)      4.31 (    3.22)      7.60 (    5.67)
  BSCO2 G/KW HR (G/HP HR)               1437.33 (1071.82)   1507.20 (1123.92)    958.30 ( 714.60)   1134.72 ( 846.16)
  BSNOX G/KW HR (G/HP HR)                 14.60 (   10.89)     12.26 (    9.15)      7.56 (    5.64)     12.24 (    9.12)
  BSFC KG/KW HR (LB/HP HR)                 .459 (    .755)      .480 (    .789)      .306 (    .503)      .365 (    .600)

TOTAL TEST RESULTS 4 BAGS                           PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          7.41 (   9.93)           90MM FILTER
   BSHC    G/KW HR (G/HP HR)   1.93 (   1.44)              SAMPLE FLOW      SCM(SCF)                 .820 ( 28.97)
   BSCO    G/KW HR (G/HP HR)   5.04 (   3.76)              MULTIPLIER FOR   G/TEST                   .782
   BSCO2   G/KW HR (G/HP HR)  1110. (   827.)              MULTIPLIER FOR   G/KW HR (G/HP HR)        .1055 ( .0787)
   BSNOX   G/KW HR (G/HP HR)   9.55 (   7.12)              MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)    .2978 ( .1351)
   BSFC   KG/KW HR (LB/HP HR)  .354 (   .583)
                                                        20 X 20 FILTERS
                                                           SAMPLE FLOW      SCM(SCF)                 0.00 (   0.0)

PART. G/KW-HR  (G/HP-HR) 0.86 (0.64)
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                          TABLE C-20. ENGINE EMISSION RESULTS
                                        H-TRANS                                          PROJECT NO. 05-5830-008

ENGINE  NO.D28                                  TEST NO.D28-6  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH              DATE  6/10/81
ENGINE  7.0 L(426. CID)                         TIME 10:55                       DIESEL   EM-465-F
CVS NO.  10                                       DYNO NO.  5                     BAG CART NO.  1

BAROMETER 735.58 MM HG(28.96 IN HG)             RELATIVE HUMIDITY ,  ENGINE-57. PCT ,  CVS-73. PCT
DRY BULB TEMP. 29.4 DEG C(85.0 DEG F)           ABSOLUTE HUMIDITY 15.3 GM/KG(107.0 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                     1                  2                  3                  4
  DESCRIPTION                                   NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)           218.4 ( 8.6)       218.4 ( 8.6)       218.4 ( 8.6)       218.4 ( 8.6)
  BLOWER INLET P MM. H2O(IN. H2O)         165.1 ( 6.5)       165.1 ( 6.5)       165.1 ( 6.5)       165.1 ( 6.5)
  BLOWER INLET TEMP. DEG. C(DEG. F)        48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                         3326.              3370.              3428.              3337.
  TIME SECONDS                               296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)         158.3 (   5590.)   160.3 ( 5663.)     163.1 ( 5761.)     158.8 ( 5608.)

  HC  SAMPLE METER/RANGE/PPM               5.5/23/  27.       8.5/23/  43.      16.5/23/  83.       8.0/23/  40.
  HC  BCKGRD METER/RANGE/PPM               8.9/ 2/   9.       9.7/ 2/  10.      11.6/ 2/  12.      14.1/ 2/  14.
  CO  SAMPLE METER/RANGE/PPM              42.3/13/  39.      67.6/13/  66.      58.6/12/ 128.      42.0/13/  39.
  CO  BCKGRD METER/RANGE/PPM                .1/13/   0.        .1/13/   0.        .7/12/   1.       1.9/13/   2.
  CO2 SAMPLE METER/RANGE/PCT              25.1/ 3/  .41      36.0/ 3/  .60      80.5/ 3/ 1.48      25.8/ 3/  .42
  CO2 BCKGRD METER/RANGE/PCT               3.8/ 3/  .06       3.3/ 3/  .05       3.5/ 3/  .05       4.7/ 3/  .07
  NOX SAMPLE METER/RANGE/PPM              13.2/13/  40.      17.4/13/  52.      41.3/13/ 124.      13.2/13/  40.
  NOX BCKGRD METER/RANGE/PPM                .6/ 2/   1.        .6/ 2/   1.        .3/ 3/   1.        .9/ 2/   1.

  DILUTION FACTOR                             32.22              21.80               8.93              31.21
  HC  CONCENTRATION PPM                       19.                33.                 72.               26.
  CO  CONCENTRATION PPM                       38.                63.                120.               36.
  CO2 CONCENTRATION PCT                       .35                .56                1.43               .35
  NOX CONCENTRATION PPM                       39.1               51.7              123.1               38.7

  HC  MASS GRAMS                              1.72               3.09               6.80               2.39
  CO  MASS GRAMS                              7.03              11.79              22.81               6.72
  CO2 MASS GRAMS                           1022.6             1631.9             4278.8             1022.3
  NOX MASS GRAMS                             11.84              15.86              38.42              11.75
  FUEL KG (LB)                              .328 (    .72)    .524 (   1.15)    1.368 (   3.02)     .328 (    .72)
  KW HR (HP HR)                              .99 (   1.32)    1.47 (   1.97)     4.85 (   6.51)      .91 (   1.22)

  BSHC G/KW HR (G/HP HR)                    1.75 (   1.30)    2.10 (   1.57)     1.40 (   1.05)     2.63 (   1.96)
  BSCO G/KW HR (G/HP HR)                    7.14 (   5.32)    8.01 (   5.98)     4.70 (   3.51)     7.38 (   5.50)
  BSCO2 G/KW HR (G/HP HR)                1038.08 ( 774.09) 1109.07 ( 827.03)  882.08 ( 657.77) 1123.00 ( 837.42)
  BSNOX G/KW HR (G/HP HR)                  12.02 (   8.96)   10.78 (   8.04)     7.92 (   5.91)    12.91 (   9.63)
  BSFC KG/KW HR (LB/HP HR)                  .333 (   .547)    .356 (   .585)     .282 (   .464)     .360 (   .593)

TOTAL TEST RESULTS 4 BAGS                         PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)           8.22 ( 11.02)          90MM FILTER
   BSHC    G/KW HR (G/HP HR)    1.71 (  1.27)            SAMPLE FLOW      SCM(SCF)                .837 ( 29.56)
   BSCO    G/KW HR (G/HP HR)    5.88 (  4.39)            MULTIPLIER FOR   G/TEST                  .765
   BSCO2   G/KW HR (G/HP HR)    968. (  722.)            MULTIPLIER FOR   G/KW HR (G/HP HR)       .0931 ( .0694)
   BSNOX   G/KW HR (G/HP HR)    9.48 (  7.07)            MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)   .3005 ( .1363)
   BSFC  KG/KW HR (LB/HP HR)    .310 (  .510)
                                                       20 X 20 FILTERS
                                                          SAMPLE FLOW      SCM(SCF)               0.00 (   0.0)

PART. G/KW-HR (G/HP-HR) 0.81 (0.60)
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                              TABLE C-21.ENGINE EMISSION RESULTS
                                         BUS CYCLE                                 PROJECT NO. 05-5830-008

ENGINE  NO.D28                              TEST NO.D28-3  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH          DATE  6/10/81
ENGINE  7.0 L(426. CID)                     TIME 11:35                          DIESEL   EM-465-F
CVS NO.  10                                   DYNO NO.  5                         BAG CART NO.  1

BAROMETER 735.58 MM HG(28.96 IN HG)         RELATIVE HUMIDITY ,  ENGINE-65. PCT ,  CVS-72. PCT
DRY BULB TEMP. 27.8 DEG C(82.0 DEG F)       ABSOLUTE HUMIDITY 15.8 GM/KG(110.8 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
   BAG NUMBER                                     1                     2                     3
   BLOWER DIF P MM. H2O(IN. H2O)             218.4 ( 8.6)         218.4 ( 8.6)         218.4 ( 8.6)
   BLOWER INLET P MM. H2O(IN. H2O)           167.6 ( 6.6)         167.6 ( 6.6)         167.6 ( 6.6)
   BLOWER INLET TEMP. DEG. C(DEG. F)          48.9 (120.0)         48.9 (120.0)         48.9 (120.0)
   BLOWER REVOLUTIONS                          3078.                3236.                3062.
   TIME SECONDS                               274.0                288.0                272.9
   TOTAL FLOW STD. CU. METRES(SCF)          146.4 (   5171.)     153.9 ( 5437.)       145.6 ( 5144.)

   HC  SAMPLE METER/RANGE/PPM                5.8/23/  29.          6.6/23/  33.         6.3/23/  32.
   HC  BCKGRD METER/RANGE/PPM                9.6/ 2/  10.         11.0/ 2/  11.        13.0/ 2/  13.
   CO  SAMPLE METER/RANGE/PPM               28.3/13/  26.         74.7/13/  73.        28.2/13/  26.
   CO  BCKGRD METER/RANGE/PPM                1.7/13/   2.          2.1/13/   2.         2.4/13/   2.
   CO2 SAMPLE METER/RANGE/PCT               25.5/ 3/  .42         34.9/ 3/  .58        26.5/ 3/  .43
   CO2 BCKGRD METER/RANGE/PCT                3.3/ 3/  .05          3.6/ 3/  .06         3.6/ 3/  .06
   NOX SAMPLE METER/RANGE/PPM               13.0/13/  39.         17.4/13/  52.        12.9/13/  39.
   NOX BCKGRD METER/RANGE/PPM                 .4/ 2/   0.           .5/ 2/   1.          .6/ 2/   1.

   DILUTION FACTOR                             31.78                22.55                30.49
   HC  CONCENTRATION PPM                       20.                  22.                  19.
   CO  CONCENTRATION PPM                       24.                  69.                  23.
   CO2 CONCENTRATION PCT                       .37                  .53                  .38
   NOX CONCENTRATION PPM                       38.6                 51.7                 38.0

   HC  MASS GRAMS                              1.66                 2.00                 1.60
   CO  MASS GRAMS                              4.04                12.37                 3.90
   CO2 MASS GRAMS                             985.0               1497.3               1014.6
   NOX MASS GRAMS                             10.80                15.23                10.60
   FUEL KG (LB)                               .314 (    .69)       .480 (   1.06)       .324 (    .71)
   KW HR (HP HR)                               .96 (   1.29)       1.60 (   2.14)        .91 (   1.22)

   BSHC G/KW HR (G/HP HR)                     1.72 (   1.29)       1.25 (    .93)       1.76 (   1.31)
   BSCO G/KW HR (G/HP HR)                     4.21 (   3.14)       7.75 (   5.78)       4.29 (   3.20)
   BSCO2 G/KW HR (G/HP HR)                 1025.83 ( 764.96)    938.09 ( 699.54)    1114.60 ( 831.16)
   BSNOX G/KW HR (G/HP HR)                   11.25 (   8.39)       9.54 (   7.12)      11.64 (   8.68)
   BSFC KG/KW HR (LB/HP HR)                   .327 (   .538)       .301 (   .495)       .355 (   .584)

TOTAL TEST RESULTS 3 BAGS                          PARTICULATE DATA, TOTAL FOR 3 BAGS

  TOTAL KW HR (HP HR)          3.47 (   4.65)         90MM FILTER
   BSHC    G/KW HR (G/HP HR)   1.52 (   1.13)            SAMPLE FLOW     SCM(SCF)                     .580 ( 20.48)
   BSCO    G/KW HR (G/HP HR)   5.86 (   4.37)            MULTIPLIER FOR  G/TEST                       .769
   BSCO2   G/KW HR (G/HP HR)   1009. (  752.)            MULTIPLIER FOR  G/KW HR (G/HP HR)            .2219 ( .1655)
   BSNOX   G/KW HR (G/HP HR)  10.57 (   7.88)            MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)        .6878 ( .3120)
   BSFC   KG/KW HR (LB/HP HR)  .323 (   .530)
                                                      20 X 20 FILTERS
                                                         SAMPLE FLOW     SCM(SCF)                     0.00 (   0.0)

PART. G/KW-HR (G/HP-HR) 1.04 (0.78)
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TABLE C-22. NOTES CONCERNING TRANSIENT TEST OPERATION OF THE DDAD 6V-71N COACH ENGINE IN MALADJUSTED CONFIGURATION

Cold Start	
C-23	Passed statistical criteria
C-24	Passed statistical criteria
Hot Start	
C-25	Passed statistical criteria
C-26	Passed statistical criteria
C-27	Passed statistical criteria
C-28	Passed statistical criteria
C-29	Failed statistical criteria. Power slope 0.6 percent too high (1.036)
Bus Cycle	
C-30	Passed statistical criteria
C-31	Passed statistical criteria

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                              TABLE C-23. ENGINE EMISSION RESULTS
                                          C-TRANS                                      PROJECT NO. 05-5830-008

ENGINE  NO.D28                                    TEST NO.D28-1  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH                DATE  6/ 2/81
ENGINE  7.0 L(426. CID)                           TIME 10:35                       DIESEL   EM-465-F
CVS NO.  10                                         DYNO NO.  5                      BAG CART NO.  1

BAROMETER 738.38 MM HG(29.07 IN HG)               RELATIVE HUMIDITY , ENGINE-60. PCT , CVS-65. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)             ABSOLUTE HUMIDITY 12.7 GM/KG( 89.1 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                 2                 3                 4
  DESCRIPTION                               NYNF              LANF               LAF              NYNF
  BLOWER DIF P MM. H2O(IN. H2O)        228.6 ( 9.0)      228.6 ( 9.0)      228.6 ( 9.0)      228.6 ( 9.0)
  BLOWER INLET P MM. H2O(IN. H2O)      177.8 ( 7.0)      177.8 ( 7.0)      177.8 ( 7.0)      177.8 ( 7.0)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)      48.9 (120.0)      48.9 (120.0)      48.9 (120.0)
  BLOWER REVOLUTIONS                      3326.             3371.             3428.             3337.
  TIME SECONDS                            296.0             300.0             305.0             297.0
  TOTAL FLOW STD. CU. METRES(SCF)      178.2 (  6293.)   180.6 ( 6378.)    183.6 ( 6485.)    178.7 ( 6313.)

  HC   SAMPLE METER/RANGE/PPM           7.6/23/  38.     10.0/23/  50.     18.3/23/  92.      8.4/23/  42.
  HC   BCKGRD METER/RANGE/PPM          14.5/ 2/  15.     14.4/ 2/  14.     15.8/ 2/  16.     17.8/ 2/  18.
  CO   SAMPLE METER/RANGE/PPM          73.9/12/ 171.     84.4/12/ 203.     84.7/11/ 398.     92.0/13/  93.
  CO   BCKGRD METER/RANGE/PPM            .5/12/   1.       .5/12/   1.       .5/11/   1.      4.6/13/   4.
  CO2  SAMPLE METER/RANGE/PCT          27.5/ 3/  .45     38.1/ 3/  .64     83.6/ 3/ 1.54     25.1/ 3/  .41
  CO2  BCKGRD METER/RANGE/PCT           4.6/ 3/  .07      4.4/ 3/  .07      4.7/ 3/  .07      5.2/ 3/  .08
  NOX  SAMPLE METER/RANGE/PPM          10.4/13/  31.     12.9/13/  39.     28.9/13/  87.      9.5/13/  29.
  NOX  BCKGRD METER/RANGE/PPM            .6/ 2/   1.       .6/ 2/   1.       .8/ 2/   1.       .9/ 2/   1.

  DILUTION FACTOR                         28.41             20.09              8.42             31.71
  HC   CONCENTRATION PPM                  24.               36.               78.               25.
  CO   CONCENTRATION PPM                 165.              195.              377.               86.
  CO2  CONCENTRATION PCT                  .38               .58              1.48               .33
  NOX  CONCENTRATION PPM                 30.7              38.0              86.0              27.6

  HC   MASS GRAMS                         2.46              3.77              8.23              2.57
  CO   MASS GRAMS                        34.16             41.07             80.51             17.95
  CO2  MASS GRAMS                       1250.0            1912.4            4979.5            1086.0
  NOX  MASS GRAMS                        10.45             13.13             30.20              9.45
  FUEL KG (LB)                         .414 (     .91)  .627 (    1.38)  1.619 (    3.57)  .354 (     .78)
  KW HR (HP HR)                        1.06 (    1.42)  1.55 (    2.07)   4.98 (    6.67)   .94 (    1.25)

  BSHC G/KW HR (G/HP HR)               2.32 (    1.73)  2.44 (    1.82)   1.65 (    1.23)   2.75 (    2.05)
  BSCO G/KW HR (G/HP HR)              32.23 (   24.03) 26.56 (   19.81)  16.18 (   12.07)  19.19 (   14.31)
  BSCO2 G/KW HR (G/HP HR)           1179.34 (  879.43) 1236.75 ( 922.25) 1000.80 ( 746.30) 1161.22 ( 865.92)
  BSNOX G/KW HR (G/HP HR)              9.86 (    7.35)  8.49 (    6.33)   6.07 (    4.53)  10.10 (    7.53)
  BSFC KG/KW HR (LB/HP HR)             .390 (    .642)  .406 (    .667)   .325 (    .535)   .379 (    .622)

TOTAL TEST RESULTS 4 BAGS                          PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.52 ( 11.42)          90MM FILTER
  BSHC   G/KW HR (G/HP HR)     2.00 (  1.49)            SAMPLE FLOW      SCM(SCF)                 .760 ( 26.85)
  BSCO   G/KW HR (G/HP HR)    20.39 ( 15.21)            MULTIPLIER FOR   G/TEST                   .949
  BSCO2  G/KW HR (G/HP HR)    1083. (  808.)            MULTIPLIER FOR   G/KW HR (G/HP HR)        .1114 ( .0831)
  BSNOX  G/KW HR (G/HP HR)     7.42 (  5.54)            MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)    .3148 ( .1428)
  BSFC  KG/KW HR (LB/HP HR)    .354 (  .582)
                                                      20 X 20 FILTERS
                                                        SAMPLE FLOW     SCM(SCF)                  79.96 (2824.2)

PART. G/KW-HR (G/HP-HR) 2.05 (1.53)
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                               TABLE C-24. ENGINE EMISSION RESULTS                        PROJECT NO. 05-5830-008
                                              C-TRANS

ENGINE   NO.D28                           TEST NO.D28-2   RUN1
ENGINE   MODEL    78 DDAD 6V-71COACH      DATE  6/ 3/81                       DIESEL    EM-465-F
ENGINE   7.0 L(426. CID)                  TIME 11:15                            BAG CART NO.  1
CVS NO.   10                                DYNO NO.  5

BAROMETER 736.85 MM HG(29.01 IN HG)       RELATIVE HUMIDITY ,  ENGINE-52. PCT ,  CVS-68. PCT
DRY BULB TEMP. 26.1 DEG C(79.0 DEG F)     ABSOLUTE HUMIDITY 11.4 GM/KG( 79.7 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                    1                 2                  3                  4
  DESCRIPTION                                 NYNF              LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)          226.1 ( 8.9)     226.1 ( 8.9)      226.1 ( 8.9)       226.1 ( 8.9)
  BLOWER INLET P MM. H2O(IN. H2O)        172.7 ( 6.8)     172.7 ( 6.8)      172.7 ( 6.8)       172.7 ( 6.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)       48.9 (120.0)     48.9 (120.0)      48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                        3326.            3371.             3428.              3337.
  TIME SECONDS                              296.0            300.0             305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)        177.8 (   6280.)  180.2 ( 6365.)    183.3 ( 6472.)     178.4 ( 6301.)

  HC  SAMPLE METER/RANGE/PPM              7.4/23/  37.     10.3/23/  51.     18.8/23/  94.       8.5/23/  43.
  HC  BCKGRD METER/RANGE/PPM              7.9/ 2/   8.      7.8/ 2/   8.      8.2/ 2/   8.       8.1/ 2/   8.
  CO  SAMPLE METER/RANGE/PPM             72.8/12/ 167.     82.7/12/ 198.     85.6/11/ 405.      97.0/13/  99.
  CO  BCKGRD METER/RANGE/PPM               .7/12/   1.      1.0/12/   2.      1.3/11/   4.       4.7/13/   4.
  CO2 SAMPLE METER/RANGE/PCT             26.9/ 3/  .44     37.2/ 3/  .63     82.3/ 3/ 1.52      24.3/ 3/  .40
  CO2 BCKGRD METER/RANGE/PCT              3.5/ 3/  .05      3.4/ 3/  .05      4.0/ 3/  .06       4.1/ 3/  .06
  NOX SAMPLE METER/RANGE/PPM             10.3/13/  31.     13.0/13/  39.     30.1/13/  90.       9.6/13/  29.
  NOX BCKGRD METER/RANGE/PPM               .9/ 2/   1.       .6/ 2/   1.      1.1/ 2/   1.        .9/ 2/   1.

  DILUTION FACTOR                          29.08            20.61              8.56              32.74
  HC  CONCENTRATION PPM                    29.              44.               87.                35.
  CO  CONCENTRATION PPM                   161.             189.              381.                92.
  CO2 CONCENTRATION PCT                    .39              .58              1.46               .33
  NOX CONCENTRATION PPM                   30.1             38.3              89.3               27.9

  HC  MASS GRAMS                           3.01             4.57              9.17               3.58
  CO  MASS GRAMS                          33.34            39.68             81.33              19.05
  CO2 MASS GRAMS                        1266.7           1902.3            4910.5             1092.5
  NOX MASS GRAMS                          10.23            13.21             31.29               9.53
  FUEL KG (LB)                            .419 (    .92)   .624 (   1.38)   1.598 (   3.52)     .358 (    .79)
  KW HR (HP HR)                           1.07 (   1.44)   1.55 (   2.07)    5.00 (   6.71)      .94 (   1.25)

  BSHC G/KW HR (G/HP HR)                  2.81 (   2.09)   2.95 (   2.20)    1.83 (   1.37)     3.83 (   2.86)
  BSCO G/KW HR (G/HP HR)                 31.09 (  23.18)  25.66 (  19.14)   16.26 (  12.13)    20.37 (  15.19)
  BSCO2 G/KW HR (G/HP HR)              1181.18 ( 880.80) 1230.24 ( 917.39) 982.01 ( 732.29)  1168.13 ( 871.07)
  BSNOX G/KW HR (G/HP HR)                 9.54 (   7.11)   8.54 (   6.37)    6.26 (   4.67)    10.19 (   7.60)
  BSFC KG/KW HR (LB/HP HR)                .391 (   .642)   .404 (   .664)    .320 (   .525)     .382 (   .629)

TOTAL TEST RESULTS 4 BAGS                       PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)         8.55 ( 11.47)        90MM FILTER
   BSHC    G/KW HR (G/HP HR)  2.38 (  1.77)          SAMPLE FLOW      SCM(SCF)                 .556 ( 19.65)
   BSCO    G/KW HR (G/HP HR) 20.27 ( 15.12)          MULTIPLIER FOR   G/TEST                  1.293
   BSCO2   G/KW HR (G/HP HR) 1072. (  800.)          MULTIPLIER FOR   G/KW HR (G/HP HR)        .1512 ( .1127)
   BSNOX   G/KW HR (G/HP HR)  7.51 (  5.60)          MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)    .4312 ( .1956)
   BSFC  KG/KW HR (LB/HP HR)  .351 (  .576)
                                                   20 X 20 FILTERS
                                                     SAMPLE FLOW      SCM(SCF)                 79.51 (2808.4)

 PART. G/KW-HR (G/HP-HR) 1.82 (1.38)
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TABLE C-25.ENGINE EMISSION RESULTS

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                                            H-TRANS                                     PROJECT NO. 05-5830-008

ENGINE  NO.D28                          TEST NO.D28-1  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH      DATE  6/ 1/81
ENGINE  7.0 L(426. CID)                 TIME 1:45                          DIESEL   EM-465-F
CVS NO.  10                               DYNO NO.  5                      BAG CART NO.  1

BAROMETER 739.14 MM HG(29.10 IN HG)     RELATIVE HUMIDITY ,  ENGINE-47. PCT ,  CVS-68. PCT
DRY BULB TEMP. 30.0 DEG C(86.0 DEG F)   ABSOLUTE HUMIDITY 12.9 GM/KG( 90.3 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                 1                  2                  3                  4
  DESCRIPTION                               NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)         226.1 ( 8.9)       226.1 ( 8.9)       226.1 ( 8.9)       226.1 ( 8.9)
  BLOWER INLET P MM. H2O(IN. H2O)       177.8 ( 7.0)       177.8 ( 7.0)       177.8 ( 7.0)       177.8 ( 7.0)
  BLOWER INLET TEMP. DEG. C(DEG. F)      48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                       3326.              3371.              3428.              3337.
  TIME SECONDS                             296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)       178.2 (   6293.)   180.6 ( 6378.)     183.6 ( 6485.)     178.7 ( 6313.)

  HC  SAMPLE METER/RANGE/PPM             7.0/23/  35.      10.5/23/  52.      18.9/23/  95.       8.3/23/  42.
  HC  BCKGRD METER/RANGE/PPM            11.3/ 2/  11.      11.1/ 2/  11.      12.8/ 2/  13.      12.6/ 2/  13.
  CO  SAMPLE METER/RANGE/PPM            96.3/13/  98.      69.5/12/ 158.      79.5/11/ 359.      84.8/13/  85.
  CO  BCKGRD METER/RANGE/PPM              .9/13/   1.        .5/12/   1.        .7/11/   2.       1.9/13/   2.
  CO2 SAMPLE METER/RANGE/PCT            22.8/ 3/  .37      34.7/ 3/  .58      81.4/ 3/ 1.50      23.4/ 3/  .38
  CO2 BCKGRD METER/RANGE/PCT             3.4/ 3/  .05       3.6/ 3/  .06       3.5/ 3/  .05       3.3/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM             8.2/13/  25.      11.5/13/  35.      28.9/13/  87.       8.7/13/  26.
  NOX BCKGRD METER/RANGE/PPM              .2/ 2/   0.        .2/ 2/   0.        .5/ 2/   1.        .5/ 2/   1.

  DILUTION FACTOR                          35.03              22.31              8.69               34.16
  HC  CONCENTRATION PPM                    24.                42.                83.                29.
  CO  CONCENTRATION PPM                    94.                152.               339.               80.
  CO2 CONCENTRATION PCT                    .32                .53                1.45               .33
  NOX CONCENTRATION PPM                    24.3               34.4               86.4               25.6

  HC  MASS GRAMS                           2.47               4.34               8.83               3.04
  CO  MASS GRAMS                           19.54              31.90              72.43              16.75
  CO2 MASS GRAMS                           1040.5             1744.5             4880.2             1082.8
  NOX MASS GRAMS                           8.29               11.87              30.34              8.74
  FUEL KG (LB)                             .340 (     .75)    .570 (    1.26)    1.584 (    3.49)    .353 (     .78)
  KW HR (HP HR)                             .96 (    1.29)    1.55 (    2.07)    4.94 (    6.62)     .92 (    1.24)

  BSHC G/KW HR (G/HP HR)                   2.57 (    1.92)    2.81 (    2.10)    1.79 (    1.33)    3.29 (    2.45)
  BSCO G/KW HR (G/HP HR)                  20.35 (   15.18)   20.63 (   15.38)   14.67 (   10.94)   18.15 (   13.54)
  BSCO2 G/KW HR (G/HP HR)               1083.64 (  808.07) 1128.22 (  841.31)  988.28 (  736.96) 1173.47 (  875.06)
  BSNOX G/KW HR (G/HP HR)                  8.63 (    6.44)    7.68 (    5.73)    6.14 (    4.58)    9.47 (    7.06)
  BSFC KG/KW HR (LB/HP HR)                 .354 (    .583)    .369 (    .606)    .321 (    .527)    .382 (    .629)

TOTAL TEST RESULTS 4 BAGS                       PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.37 ( 11.22)        90MM FILTER
   BSHC   G/KW HR (G/HP HR)    2.23 (  1.66)          SAMPLE FLOW      SCM(SCF)                  .823 ( 29.08)
   BSCO   G/KW HR (G/HP HR)   16.81 ( 12.53)          MULTIPLIER FOR   G/TEST                    .876
   BSCO2  G/KW HR (G/HP HR)   1046. (  780.)          MULTIPLIER FOR   G/KW HR (G/HP HR)         .1047 ( .0780)
   BSNOX  G/KW HR (G/HP HR)    7.08 (  5.28)          MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)     .3075 ( .1395)
   BSFC   KG/KW HR (LB/HP HR)  .340 (  .559)
                                                    20 X 20 FILTERS
                                                      SAMPLE FLOW     SCM(SCF)                   78.94 (2788.2)

PART. G/KW-HR (G/HP-HR) 1.56 (1.16)
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                          TABLE C-26. ENGINE EMISSION RESULTS
                                        H-TRANS                                PROJECT NO. 05-5830-008

ENGINE  NO.D28                                TEST NO.D28-2  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH            DATE  6/ 2/81
ENGINE  7.0 L(426. CID)                       TIME 11:15                       DIESEL   EM-465-F
CVS NO.  10                                    DYNO NO.  5                      BAG CART NO.  1

BAROMETER 738.38 MM HG(29.07 IN HG)           RELATIVE HUMIDITY ,  ENGINE-49. PCT ,  CVS-65. PCT
DRY BULB TEMP. 28.9 DEG C(84.0 DEG F)         ABSOLUTE HUMIDITY 12.6 GM/KG( 88.3 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                  2                  3                  4
  DESCRIPTION                                NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)         221.0 ( 8.7)       221.0 ( 8.7)       221.0 ( 8.7)       221.0 ( 8.7)
  BLOWER INLET P MM. H2O(IN. H2O)       172.7 ( 6.8)       172.7 ( 6.8)       172.7 ( 6.8)       172.7 ( 6.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)      48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                      3326.              3371.              3428.              3337.
  TIME SECONDS                            296.0              300.0              305.0              296.9
  TOTAL FLOW STD. CU. METRES(SCF)       178.5 (  6306.)    180.9 ( 6391.)     184.0 ( 6499.)     179.1 ( 6326.)

  HC  SAMPLE METER/RANGE/PPM             7.6/23/  38.      10.6/23/  53.      18.7/23/  93.       8.6/23/  43.
  HC  BCKGRD METER/RANGE/PPM            13.8/ 2/  14.      14.0/ 2/  14.      15.3/ 2/  15.      15.3/ 2/  15.
  CO  SAMPLE METER/RANGE/PPM            92.0/13/  93.      70.5/12/ 161.      77.6/11/ 345.      85.4/13/  85.
  CO  BCKGRD METER/RANGE/PPM              .5/13/   0.        .6/12/   1.        .8/11/   2.       2.0/13/   2.
  CO2 SAMPLE METER/RANGE/PCT            23.6/ 3/  .38      35.4/ 3/  .59      80.2/ 3/ 1.47      23.9/ 3/  .39
  CO2 BCKGRD METER/RANGE/PCT             3.3/ 3/  .05       3.7/ 3/  .06       3.6/ 3/  .06       3.6/ 3/  .06
  NOX SAMPLE METER/RANGE/PPM             9.4/13/  28.      12.7/13/  38.      30.0/13/  90.       9.8/13/  29.
  NOX BCKGRD METER/RANGE/PPM              .6/ 2/   1.        .8/ 2/   1.       1.0/ 2/   1.        .8/ 2/   1.

  DILUTION FACTOR                        33.83              21.83               8.84              33.41
  HC  CONCENTRATION PPM                  25.                40.                80.                28.
  CO  CONCENTRATION PPM                  90.               154.               326.                81.
  CO2 CONCENTRATION PCT                   .33                .54               1.42                .33
  NOX CONCENTRATION PPM                  27.7               37.4               89.1               28.6

  HC  MASS GRAMS                          2.55               4.14               8.48               2.90
  CO  MASS GRAMS                         18.66              32.53              69.88              16.92
  CO2 MASS GRAMS                       1092.9             1785.7             4801.4             1098.8
  NOX MASS GRAMS                          9.47              12.94              31.35               9.80
  FUEL KG (LB)                            .357 (    .79)    .583 (   1.29)    1.558 (   3.43)     .358 (    .79)
  KW HR (HP HR)                           .96 (   1.29)    1.55 (   2.07)     4.93 (   6.61)      .92 (   1.24)

  BSHC G/KW HR (G/HP HR)                 2.66 (   1.98)    2.68 (   2.00)     1.72 (   1.28)     3.14 (   2.34)
  BSCO G/KW HR (G/HP HR)                19.43 (  14.49)   21.04 (  15.69)    14.19 (  10.58)    18.34 (  13.67)
  BSCO2 G/KW HR (G/HP HR)             1138.18 ( 848.74) 1154.83 ( 861.16)   974.79 ( 726.90)  1190.72 ( 887.92)
  BSNOX G/KW HR (G/HP HR)                9.86 (   7.36)    8.37 (   6.24)     6.36 (   4.75)    10.63 (   7.92)
  BSFC KG/KW HR (LB/HP HR)               .371 (   .610)    .377 (   .620)     .316 (   .520)     .388 (   .638)

TOTAL TEST RESULTS 4 BAGS                       PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)         8.35 ( 11.20)       90MM FILTER
   BSHC   G/KW HR (G/HP HR)   2.16 (  1.61)         SAMPLE FLOW       SCM(SCF)                  .749 ( 26.45)
   BSCO   G/KW HR (G/HP HR)  16.52 ( 12.32)         MULTIPLIER FOR    G/TEST                    .965
   BSCO2  G/KW HR (G/HP HR)  1051. (  784.)         MULTIPLIER FOR    G/KW HR (G/HP HR)         .1155 ( .0861)
   BSNOX  G/KW HR (G/HP HR)   7.61 (  5.67)         MULTIPLIER FOR    G/KG FUEL (G/LB FUEL)     .3380 ( .1533)
   BSFC  KG/KW HR (LB/HP HR)  .342 (  .562)
                                                  20 X 20 FILTERS
                                                    SAMPLE FLOW       SCM(SCF)                 80.36 (2838.3)

PART. G/KW-HR (G/HP-HR) 1.75 (1.31)
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TABLE C-27. ENGINE EMISSION RESULTS

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                                      H-TRANS                                   PROJECT NO. 05-5830-008

ENGINE  NO.D28                       TEST NO.D28-3  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH   DATE  6/ 2/81
ENGINE  7.0 L(426. CID)              TIME 11:55                   DIESEL   EM-465-F
CVS NO.  10                           DYNO NO.  5                  BAG CART NO.  1

BAROMETER 738.38 MM HG(29.07 IN HG)  RELATIVE HUMIDITY , ENGINE-48. PCT , CVS-62. PCT
DRY BULB TEMP. 29.4 DEG C(85.0 DEG F) ABSOLUTE HUMIDITY 12.8 GM/KG( 89.4 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                  1                 2                 3                 4
  DESCRIPTION                               NYNF              LANF               LAF              NYNF
  BLOWER DIF P MM. H2O(IN. H2O)        228.6 ( 9.0)      228.6 ( 9.0)      228.6 ( 9.0)      228.6 ( 9.0)
  BLOWER INLET P MM. H2O(IN. H2O)      177.8 ( 7.0)      177.8 ( 7.0)      177.8 ( 7.0)      177.8 ( 7.0)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)      48.9 (120.0)      48.9 (120.0)      48.9 (120.0)
  BLOWER REVOLUTIONS                      3326.             3371.             3428.             3337.
  TIME SECONDS                            296.0             300.0             305.0             297.0
  TOTAL FLOW STD. CU. METRES(SCF)      178.0 (   6289.) 180.5 ( 6374.)    183.5 ( 6481.)    178.6 ( 6309.)

  HC  SAMPLE METER/RANGE/PPM            7.4/23/  37.     10.4/23/  52.     18.9/23/  95.      8.3/23/  42.
  HC  BCKGRD METER/RANGE/PPM           15.3/ 2/  15.     15.8/ 2/  16.     18.1/ 2/  18.     18.4/ 2/  18.
  CO  SAMPLE METER/RANGE/PPM           91.0/13/  92.     68.4/12/ 155.     77.6/11/ 345.     87.7/13/  88.
  CO  BCKGRD METER/RANGE/PPM             .8/13/   1.      1.2/12/   2.      1.0/11/   3.      2.8/13/   3.
  CO2 SAMPLE METER/RANGE/PCT           23.5/ 3/  .38     35.0/ 3/  .59     79.5/ 3/ 1.46     23.8/ 3/  .39
  CO2 BCKGRD METER/RANGE/PCT            3.7/ 3/  .06      4.1/ 3/  .06      3.6/ 3/  .06      3.5/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM            9.4/13/  28.     12.7/13/  38.     30.5/13/  91.     10.0/13/  30.
  NOX BCKGRD METER/RANGE/PPM            1.1/ 2/   1.       .8/ 2/   1.      1.4/ 2/   1.       .8/ 2/   1.

  DILUTION FACTOR                         33.99             22.12              8.92             33.54
  HC  CONCENTRATION PPM                   22.               37.               79.               24.
  CO  CONCENTRATION PPM                   88.              148.              326.               83.
  CO2 CONCENTRATION PCT                    .33               .53              1.41               .33
  NOX CONCENTRATION PPM                   27.2              37.4              90.1              29.3

  HC  MASS GRAMS                           2.30              3.85              8.32              2.46
  CO  MASS GRAMS                          18.34             31.04             69.67             17.28
  CO2 MASS GRAMS                        1064.6            1737.0            4739.5            1095.0
  NOX MASS GRAMS                           9.28             12.91             31.63             10.02
  FUEL KG (LB)                             .347 (    .77)    .567 (   1.25)   1.538 (   3.39)    .356 (    .79)
  KW HR (HP HR)                            .96 (   1.29)    1.53 (   2.06)    4.91 (   6.59)     .94 (   1.25)

  BSHC G/KW HR (G/HP HR)                  2.39 (   1.78)    2.51 (   1.87)    1.69 (   1.26)    2.63 (   1.96)
  BSCO G/KW HR (G/HP HR)                 19.10 (  14.25)   20.24 (  15.09)   14.18 (  10.57)   18.48 (  13.78)
  BSCO2 G/KW HR (G/HP HR)              1108.78 ( 826.82) 1132.51 ( 844.51)  964.66 ( 719.34) 1170.86 ( 873.11)
  BSNOX G/KW HR (G/HP HR)                 9.66 (   7.21)    8.42 (   6.28)    6.44 (   4.80)   10.72 (   7.99)
  BSFC KG/KW HR (LB/HP HR)                .362 (   .594)    .370 (   .608)    .313 (   .515)    .381 (   .626)

TOTAL TEST RESULTS 4 BAGS                      PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)        8.34 ( 11.19)       90MM FILTER
   BSHC   G/KW HR (G/HP HR)  2.03 (  1.31)          SAMPLE FLOW      SCM(SCF)                .750 ( 26.49)
   BSCO   G/KW HR (G/HP HR) 16.34 ( 12.19)          MULTIPLIER FOR   G/TEST                  .961
   BSCO2  G/KW HR (G/HP HR) 1035. (  772.)          MULTIPLIER FOR   G/KW HR (G/HP HR)       .1152 ( .0859)
   BSNOX  G/KW HR (G/HP HR)  7.65 (  5.71)          MULTIPLIER FOR   G/KG FUEL (G/LB FUEL)   .3422 ( .1552)
   BSFC  KG/KW HR (LB/HP HR)  .337 (  .553)
                                                 20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 1.69 (1.26)                SAMPLE FLOW     SCM(SCF)                79.50 (2808.0)
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                                   TABLE C-28.ENGINE EMISSION RESULTS
                                                H-TRANS                                          PROJECT NO. 05-5830-008

ENGINE  NO.D28                                     TEST NO.D28-4  RUN1
ENGINE  MODEL    78 DDAD 6V-71COACH                DATE  6/ 2/81
ENGINE  7.0 L(426. CID)                            TIME 12:35                        DIESEL   EM-465-F
CVS NO.  10                                         DYNO NO.  5                       BAG CART NO.  1

BAROMETER 737.87 MM HG(29.05 IN HG)                RELATIVE HUMIDITY ,  ENGINE-58. PCT ,  CVS-62. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)              ABSOLUTE HUMIDITY 12.3 GM/KG( 86.0 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                             1                  2                  3                  4
  DESCRIPTION                                          NYNF               LANF                LAF               NYNF
  BLOWER DIF P MM. H2O(IN. H2O)                   226.1 ( 8.9)       226.1 ( 8.9)       226.1 ( 8.9)       226.1 ( 8.9)
  BLOWER INLET P MM. H2O(IN. H2O)                 177.8 ( 7.0)       177.8 ( 7.0)       177.8 ( 7.0)       177.8 ( 7.0)
  BLOWER INLET TEMP. DEG. C(DEG. F)                48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                                 3326.              3370.              3428.              3337.
  TIME SECONDS                                       296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)                177.5 (   6268.)   179.8 ( 6351.)     182.9 ( 6460.)     178.0 ( 6288.)

  HC  SAMPLE METER/RANGE/PPM                      7.5/23/  37.       10.0/23/  50.      18.5/23/  92.      8.1/23/  41.
  HC  BCKGRD METER/RANGE/PPM                     12.5/ 2/  13.       12.0/ 2/  12.      12.3/ 2/  12.     12.0/ 2/  12.
  CO  SAMPLE METER/RANGE/PPM                     93.2/13/  94.       69.1/12/ 157.      77.6/11/ 345.     90.2/13/  91.
  CO  BCKGRD METER/RANGE/PPM                      1.0/13/   1.         .7/12/   1.        .7/11/   2.      1.8/13/   2.
  CO2 SAMPLE METER/RANGE/PCT                     23.1/ 3/  .37       35.0/ 3/  .59      79.8/ 3/ 1.47     23.4/ 3/  .38
  CO2 BCKGRD METER/RANGE/PCT                      3.4/ 3/  .05        3.2/ 3/  .05       3.6/ 3/  .06      3.4/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM                      9.5/13/  29.       12.8/13/  38.      30.1/13/  90.      9.9/13/  30.
  NOX BCKGRD METER/RANGE/PPM                       .6/ 2/   1.         .8/ 2/   1.       1.4/ 2/   1.        .9/ 2/   1.

  DILUTION FACTOR                                   34.57              22.12               8.89              34.12
  HC  CONCENTRATION PPM                               25.                39.                81.                29.
  CO  CONCENTRATION PPM                               91.               151.               327.                87.
  CO2 CONCENTRATION PCT                               .32                .54               1.42                .33
  NOX CONCENTRATION PPM                              28.0               37.5               89.1               28.9

  HC  MASS GRAMS                                     2.59               4.01               8.59               2.99
  CO  MASS GRAMS                                    18.76              31.52              69.60              17.98
  CO2 MASS GRAMS                                   1053.2             1774.7             4744.7             1073.7
  NOX MASS GRAMS                                     9.51              12.91              31.18               9.86
  FUEL KG (LB)                                     .344 (     .76)   .579 (    1.28)   1.540 (    3.39)    .351 (     .77)
  KW HR (HP HR)                                     .96 (    1.29)   1.55 (    2.07)    4.93 (    6.61)     .94 (    1.25)

  BSHC G/KW HR (G/HP HR)                          2.70 (   2.01)     2.60 (   1.94)     1.74 (   1.30)     3.19 (   2.38)
  BSCO G/KW HR (G/HP HR)                         19.54 (  14.57)    20.38 (  15.20)    14.13 (  10.54)    19.23 (  14.34)
  BSCO2 G/KW HR (G/HP HR)                      1096.92 ( 817.97)  1147.70 ( 855.84)   963.27 ( 718.31)  1148.02 ( 856.08)
  BSNOX G/KW HR (G/HP HR)                         9.91 (   7.39)     8.35 (   6.23)     6.33 (   4.72)    10.54 (   7.86)
  BSFC KG/KW HR (LB/HP HR)                        .358 (   .589)     .375 (   .616)     .313 (   .514)     .375 (   .616)

TOTAL TEST RESULTS 4 BAGS                          PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)          8.37 ( 11.22)          90MM FILTER
  BSHC    G/KW HR (G/HP HR)    2.17 (  1.62)              SAMPLE FLOW     SCM(SCF)                   .714 ( 25.23)
  BSCO    G/KW HR (G/HP HR)   16.48 ( 12.29)              MULTIPLIER FOR  G/TEST                    1.005
  BSCO2   G/KW HR (G/HP HR)   1033. (  771.)              MULTIPLIER FOR  G/KW HR (G/HP HR)          .1201 ( .0896)
  BSNOX   G/KW HR (G/HP HR)    7.58 (  5.66)              MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)      .3573 ( .1621)
  BSFC   KG/KW HR (LB/HP HR)   .336 (  .553)
                                                       20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 1.68 (1.25)                       SAMPLE FLOW     SCM(SCF)                  77.36 (2732.2)
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                                   TABLE C-29. ENGINE EMISSION RESULTS
                                               H-TRANS                                          PROJECT NO. 05-5830-008

ENGINE  NO.D28                                TEST NO.D28-5  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH             DATE  6/ 3/81
ENGINE  7.0 L(426. CID)                        TIME 11:55                          DIESEL   EM-465-F
CVS NO.  10                                     DYNO NO.  5                          BAG CART NO.  1

BAROMETER 736.60 MM HG(29.00 IN HG)            RELATIVE HUMIDITY ,  ENGINE-52. PCT ,  CVS-65. PCT
DRY BULB TEMP. 27.2 DEG C(81.0 DEG F)          ABSOLUTE HUMIDITY 12.2 GM/KG( 85.2 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                        1                  2                  3                  4
  DESCRIPTION                                      NYNF               LANF               LAF                NYNF
  BLOWER DIF P MM. H2O(IN. H2O)                223.5 ( 8.8)       223.5 ( 8.8)       223.5 ( 8.8)       223.5 ( 8.8)
  BLOWER INLET P MM. H2O(IN. H2O)              175.3 ( 6.9)       175.3 ( 6.9)       175.3 ( 6.9)       175.3 ( 6.9)
  BLOWER INLET TEMP. DEG. C(DEG. F)             48.9 (120.0)       48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                               3326.              3371.              3427.              3338.
  TIME SECONDS                                    296.0              300.0              305.0              297.0
  TOTAL FLOW STD. CU. METRES(SCF)              177.5 (  6268.)    179.9 ( 6353.)     182.9 ( 6459.)     178.1 ( 6291.)

  HC  SAMPLE METER/RANGE/PPM                   7.6/23/  38.      10.8/23/  54.      19.7/23/  98.       8.8/23/  44.
  HC  BCKGRD METER/RANGE/PPM                  10.6/ 2/  11.      11.6/ 2/  12.      12.7/ 2/  13.      14.1/ 2/  14.
  CO  SAMPLE METER/RANGE/PPM                  97.1/13/  99.      72.0/12/ 165.      78.3/11/ 350.      91.8/13/  93.
  CO  BCKGRD METER/RANGE/PPM                   1.4/13/   1.        .9/12/   2.        .8/11/   2.       3.2/13/   3.
  CO2 SAMPLE METER/RANGE/PCT                  23.5/ 3/  .38      35.9/ 3/  .60      79.1/ 3/ 1.45      23.3/ 3/  .38
  CO2 BCKGRD METER/RANGE/PCT                   2.9/ 3/  .04       3.6/ 3/  .06       3.4/ 3/  .05       3.5/ 3/  .05
  NOX SAMPLE METER/RANGE/PPM                   9.8/13/  29.      13.1/13/  39.      30.8/13/  92.      10.0/13/  30.
  NOX BCKGRD METER/RANGE/PPM                    .5/ 2/   1.        .8/ 2/   1.       1.1/ 2/   1.        .9/ 2/   1.

  DILUTION FACTOR                                 33.93              21.49               8.97              34.22
  HC  CONCENTRATION PPM                           28.                43.                87.                30.
  CO  CONCENTRATION PPM                           95.               158.               331.                87.
  CO2 CONCENTRATION PCT                           .34                .55               1.40                .33
  NOX CONCENTRATION PPM                           28.8               38.5               91.5               29.1

  HC  MASS GRAMS                                  2.83               4.48               9.19               3.13
  CO  MASS GRAMS                                 19.58              33.11              70.48              18.09
  CO2 MASS GRAMS                                1100.3             1810.2             4704.4             1063.6
  NOX MASS GRAMS                                  9.79              13.26              32.01               9.91
  FUEL KG (LB)                                   .360 (    .79)     .592 (   1.30)    1.528 (   3.37)     .348 (    .77)
  KW HR (HP HR)                                   .97 (   1.30)     1.55 (   2.07)     4.95 (   6.64)      .94 (   1.25)

  BSHC G/KW HR (G/HP HR)                         2.91 (   2.17)     2.90 (   2.16)     1.86 (   1.38)     3.34 (   2.49)
  BSCO G/KW HR (G/HP HR)                        20.13 (  15.01)    21.41 (  15.97)    14.24 (  10.62)    19.35 (  14.43)
  BSCO2 G/KW HR (G/HP HR)                     1131.21 ( 843.55)  1170.71 ( 873.00)   950.28 ( 708.62)  1137.20 ( 848.01)
  BSNOX G/KW HR (G/HP HR)                       10.07 (   7.51)     8.58 (   6.40)     6.47 (   4.82)    10.60 (   7.90)
  BSFC KG/KW HR (LB/HP HR)                       .370 (   .608)     .383 (   .629)     .309 (   .507)     .372 (   .611)

TOTAL TEST RESULTS 4 BAGS                                PARTICULATE DATA, TOTAL FOR 4 BAGS

  TOTAL KW HR (HP HR)           8.40 ( 11.27)              90MM FILTER
   BSHC   G/KW HR (G/HP HR)     2.34 (  1.74)                 SAMPLE FLOW     SCM(SCF)                 .585 ( 20.65)
   BSCO   G/KW HR (G/HP HR)    16.81 ( 12.53)                 MULTIPLIER FOR  G/TEST                  1.229
   BSCO2  G/KW HR (G/HP HR)    1033. (  770.)                 MULTIPLIER FOR  G/KW HR (G/HP HR)       .1462 ( .1090)
   BSNOX  G/KW HR (G/HP HR)     7.73 (  5.77)                 MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)   .4346 ( .1971)
   BSFC   KG/KW HR (LB/HP HR)   .336 (  .553)
                                                           20 X 20 FILTERS
                                                              SAMPLE FLOW     SCM(SCF)                78.31 (2766.0)
PART G/KW-HR (G/HP-HR) 1.62 (1.21)
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                                   TABLE C-30. ENGINE EMISSION RESULTS
                                                H-TRANS                                    PROJECT NO. 05-5830-008

ENGINE  NO.D28                              TEST NO.D28-1  RUN1
ENGINE  MODEL    78 DDAD 6V-71COACH         DATE  6/ 1/81
ENGINE  7.0 L(426. CID)                     TIME 2:25                          DIESEL   EM-465-F
CVS NO.  10                                   DYNO NO.  5                        BAG CART NO.  1

BAROMETER 738.12 MM HG(29.06 IN HG)         RELATIVE HUMIDITY ,  ENGINE-51. PCT ,  CVS-68. PCT
DRY BULB TEMP. 28.9 DEG C(84.0 DEG F)       ABSOLUTE HUMIDITY 13.2 GM/KG( 92.1 GRAINS/LB)      NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                        1                  2                  3
  BLOWER DIF P MM. H2O(IN. H2O)             226.1 ( 8.9)       226.1 ( 8.9)       226.1 ( 8.9)
  BLOWER INLET P MM. H2O(IN. H2O)           172.7 ( 6.8)       172.7 ( 6.8)       172.7 ( 6.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)          48.9 (120.0)       48.9 (120.0)       48.9 (120.0)
  BLOWER REVOLUTIONS                           3067.              3236.              3066.
  TIME SECONDS                                 273.0              288.0              272.9
  TOTAL FLOW STD. CU. METRES(SCF)          164.4 (  5807.)   173.5 ( 6127.)     164.4 ( 5805.)

  HC   SAMPLE METER/RANGE/PPM               8.1/23/  40.       8.0/23/  40.       7.9/23/  40.
  HC   BCKGRD METER/RANGE/PPM               8.8/ 2/   9.       8.8/ 2/   9.       8.8/ 2/   9.
  CO   SAMPLE METER/RANGE/PPM              50.3/12/ 107.      84.7/12/ 204.      48.3/12/ 102.
  CO   BCKGRD METER/RANGE/PPM                .5/12/   1.        .7/12/   1.        .6/12/   1.
  CO2  SAMPLE METER/RANGE/PCT              27.0/ 3/  .44      33.3/ 3/  .55      26.2/ 3/  .43
  CO2  BCKGRD METER/RANGE/PCT               3.1/ 3/  .05       2.8/ 3/  .04       2.7/ 3/  .04
  NOX  SAMPLE METER/RANGE/PPM               9.9/13/  30.      12.2/13/  37.       9.7/13/  29.
  NOX  BCKGRD METER/RANGE/PPM                .6/ 2/   1.        .5/ 2/   1.        .6/ 2/   1.

  DILUTION FACTOR                            29.33              23.16              30.29
  HC   CONCENTRATION PPM                     32.                32.                31.
  CO   CONCENTRATION PPM                     103.               196.               98.
  CO2  CONCENTRATION PCT                     .40                .51                .39
  NOX  CONCENTRATION PPM                     29.0               36.1               28.4

  HC   MASS GRAMS                            3.02               3.16               2.94
  CO   MASS GRAMS                            19.63              39.61              18.68
  CO2  MASS GRAMS                            1194.5             1632.6             1169.7
  NOX  MASS GRAMS                            9.12               11.99              8.93
  FUEL KG (LB)                               .390 (    .86)     .538 (   1.19)     .381 (    .84)
  KW HR (HP HR)                              1.06 (   1.42)     1.67 (   2.24)     1.06 (   1.42)

  BSHC G/KW HR (G/HP HR)                     2.85 (   2.12)     1.89 (   1.41)     2.78 (   2.07)
  BSCO G/KW HR (G/HP HR)                    18.52 (  13.81)    23.70 (  17.67)    17.63 (  13.14)
  BSCO2 G/KW HR (G/HP HR)                 1126.97 ( 840.38)   977.02 ( 728.56)  1103.57 ( 822.93)
  BSNOX G/KW HR (G/HP HR)                    8.61 (   6.42)     7.17 (   5.35)     8.42 (   6.28)
  BSFC KG/KW HR (LB/HP HR)                   .367 (   .604)     .322 (   .529)     .360 (   .591)

TOTAL TEST RESULTS 3 BAGS                          PARTICULATE DATA, TOTAL FOR 3 BAGS

  TOTAL KW HR (HP HR)          3.79 (   5.08)          90MM FILTER
  BSHC    G/KW HR (G/HP HR)    2.41 (   1.79)               SAMPLE FLOW     SCM(SCF)                   .590 ( 20.84)
  BSCO    G/KW HR (G/HP HR)   20.55 (  15.33)               MULTIPLIER FOR  G/TEST                     .851
  BSCO2   G/KW HR (G/HP HR)   1054. (   786.)               MULTIPLIER FOR  G/KW HR (G/HP HR)          .2245 ( .1674)
  BSNOX   G/KW HR (G/HP HR)    7.92 (   5.91)               MULTIPLIER FOR  G/KG FUEL (G/LB FUEL)      .6504 ( .2950)
  BSFC    KG/KW HR (LB/HP HR)  .345 (   .567)
                                                       20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 1.94 (1.45)                        SAMPLE FLOW    SCM(SCF)                  55.71 (1967.8)
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                          TABLEC-31. ENGINE EMISSION RESULTS
                                       H-TRANS                                  PROJECT NO. 05-5830-008

ENGINE  NO.D28                         TEST NO.D28-2  RUN1
ENGINE  MODEL   78 DDAD 6V-71COACH     DATE  6/ 1/81
ENGINE  7.0 L(426. CID)                TIME 3:05                       DIESEL   EM-465-F
CVS NO.  10                             DYNO NO.  5                     BAG CART NO.  1

BAROMETER 736.85 MM HG(29.01 IN HG)    RELATIVE HUMIDITY , ENGINE-54. PCT ,  CVS-68. PCT
DRY BULB TEMP. 27.8 DEG C(82.0 DEG F)  ABSOLUTE HUMIDITY 13.1 GM/KG( 91.5 GRAINS/LB)     NOX HUMIDITY C.F. 1.0000

BAG RESULTS
  BAG NUMBER                                 1               2               3
  BLOWER DIF P MM. H2O(IN. H2O)        226.1 ( 8.9)    226.1 ( 8.9)    226.1 ( 8.9)
  BLOWER INLET P MM. H2O(IN. H2O)      172.7 ( 6.8)    172.7 ( 6.8)    172.7 ( 6.8)
  BLOWER INLET TEMP. DEG. C(DEG. F)     48.9 (120.0)    48.9 (120.0)    48.9 (120.0)
  BLOWER REVOLUTIONS                      3067.           3236.           3067.
  TIME SECONDS                            273.0           288.0           273.0
  TOTAL FLOW STD. CU. METRES(SCF)      164.0 (  5793.) 173.1 ( 6113.)  164.0 ( 5793.)

  HC  SAMPLE METER/RANGE/PPM            8.4/23/  42.     8.4/23/  42.    8.4/23/  42.
  HC  BCKGRD METER/RANGE/PPM            8.7/ 2/   9.     8.8/ 2/   9.    9.5/ 2/  10.
  CO  SAMPLE METER/RANGE/PPM           51.0/12/ 108.    86.1/12/ 208.   49.2/12/ 104.
  CO  BCKGRD METER/RANGE/PPM             .4/12/   1.      .4/12/   1.     .5/12/   1.
  CO2 SAMPLE METER/RANGE/PCT           26.3/ 3/  .43    33.6/ 3/  .56   26.3/ 3/  .43
  CO2 BCKGRD METER/RANGE/PCT            2.6/ 3/  .04     2.7/ 3/  .04    2.8/ 3/  .04
  NOX SAMPLE METER/RANGE/PPM            9.9/13/  30.    12.4/13/  37.    9.9/13/  30.
  NOX BCKGRD METER/RANGE/PPM             .4/ 2/   0.      .4/ 2/   0.     .4/ 2/   0.

  DILUTION FACTOR                        30.11           22.92           30.14
  HC  CONCENTRATION PPM                  34.             34.             33.
  CO  CONCENTRATION PPM                 104.            201.            100.
  CO2 CONCENTRATION PCT                  .39             .52             .39
  NOX CONCENTRATION PPM                 29.4            36.7            29.4

  HC  MASS GRAMS                         3.20            3.35            3.12
  CO  MASS GRAMS                        19.94           40.49           19.08
  CO2 MASS GRAMS                      1177.1          1650.7          1168.2
  NOX MASS GRAMS                         9.21           12.14            9.21
  FUEL KG (LB)                           .384 (   .85)   .544 (  1.20)   .381 (   .84)
  KW HR (HP HR)                         1.06 (  1.42)   1.67 (  2.24)   1.07 (  1.44)

  BSHC G/KW HR (G/HP HR)                3.02 (  2.25)   2.01 (  1.50)   2.91 (  2.17)
  BSCO G/KW HR (G/HP HR)               18.81 ( 14.03)  24.23 ( 18.07)  17.80 ( 13.27)
  BSCO2 G/KW HR (G/HP HR)            1110.58 ( 828.16) 987.88 ( 736.66) 1089.31 ( 812.30)
  BSNOX G/KW HR (G/HP HR)               8.69 (  6.48)   7.26 (  5.42)   8.59 (  6.41)
  BSFC KG/KW HR (LB/HP HR)              .363 (  .596)   .326 (  .535)   .355 (  .584)

TOTAL TEST RESULTS 3 BAGS                       PARTICULATE DATA, TOTAL FOR 3 BAGS

 TOTAL KW HR (HP HR)          3.80 (  5.10)       90MM FILTER
  BSHC    G/KW HR (G/HP HR)   2.54 (  1.90)          SAMPLE FLOW       SCM(SCF)                 .624 ( 22.04)
  BSCO    G/KW HR (G/HP HR)  20.91 ( 15.59)          MULTIPLIER FOR    G/TEST                   .803
  BSCO2   G/KW HR (G/HP HR)  1051. (  783.)          MULTIPLIER FOR    G/KW HR (G/HP HR)        .2112 ( .1575)
  BSNOX   G/KW HR (G/HP HR)   8.04 (  5.99)          MULTIPLIER FOR    G/KG FUEL (G/LB FUEL)    .6134 ( .2782)
  BSFC   KG/KW HR (LB/HP HR)  .344 (  .566)
                                                  20 X 20 FILTERS
PART. G/KW-HR (G/HP-HR) 1.99 (1.48)                  SAMPLE FLOW      SCM(SCF)                 55.32 (1954.0)
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TABLE C-32. SUMMARY OF INDIVIDUAL HYDROCARBONS FROM TRANSIENT OPERATION OF THE DDAD 6V-71N COACH ENGINE

Cycle Type	Units	Methane	Ethylene	Ethane	Acetylene	Propylene	Benzene	Toluene	"Total"
Baseline	mg/test	--	790	--	--	410	--	63	1300
Cold	mg/kW/hr		120			60		9.2	190
Start	mg/kg fuel		320			160		25	500
Baseline	mg/test	--	1000	27	--	520	86	--	1600
Hot	mg/kW-hr		120	3.2		61	10		190
Start	mg/kg fuel		390	11		200	33		630
Maladjusted	mg/test	94	1200	--	71	570	72	--	2000
Cold	mg/kW/hr	11	140	--	8.3	67	8.5		230
Start	mg/kg fuel	31	400		23	190	24		670
Maladjusted	mg/test	14	1100	36	50	500	--	--	1700
Hot	mg/kW/hr	1.7	130	4.3	6.0	60			200
Start	mg/kg fuel	5.0	380	13	18	180			600

Note: No propane was detected.

TABLE C-33. SUMMARY OF INDIVIDUAL HYDROCARBONS FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN BASELINE CONFIGURATION

		Test Condition, rpm/load, %						
Hydrocarbon	Units	1260 2	1260 50	1260 100	Idle	2100 100	2100 50	2100 2
Methane	mg/hr	--	--	350	--	63	--	110
	mg/kW-hr			3.6		0.48		41
	mg/kg fuel			14		1.8		12
Ethylene	mg/hr	3200	1100	7300	730	15000	3400	2100
	mg/kW-hr	1800	22	74	--	110	52	780
	mg/kg fuel	850	90	290	870	420	160	230
Ethane	mg/hr	--	--	460	--	300	--	79
	mg/kW-hr			4.7		2.3		29
	mg/kg fuel			18		8.4		8.6
Acetylene	mg/hr	240	--	--	--	780	--	--
	mg/kW-hr	130				5.9		
	mg/kg fuel	63				22		
Propylene	mg/hr	1300	460	2900	490	6800	1500	1000
	mg/kW-hr	730	9.4	29	--	52	23	370
	mg/kg fuel	340	38	120	580	190	72	110
Benzene	mg/hr	560	--	730	--	1300	--	200
	mg/kW-hr	310		7.4		9.9		74
	mg/kg fuel	150		29		36		22
Toluene	mg/hr	--	--	630	--	1000	--	430
	mg/kW-hr			6.4		7.6		160
	mg/kg fuel			25		28		47

No propane was detected

TABLE C-34. SUMMARY OF INDIVIDUAL HYDROCARBONS FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN MALADJUSTED CONFIGURATION

		Test Condition, rpm/load, %						
Hydrocarbon		1260 2	1260 50	1260 100	Idle	2100 100	2100 50	2100 2
Methane	mg/hr	260	390	2900	80	4400	--	43
	mg/kW-hr	150	8.5	31	--	35	--	18
	mg/kg fuel	66	33	110	83	120	--	4.6
Ethylene	mg/hr	3700	1400	8700	410	--	7000	3600
	mg/kW-hr	2100	31	94	--	--	110	1500
	mg/kg fuel	930	120	340	430	--	330	380
Ethane	mg/hr	--	--	390	--	540	170	--
	mg/kW-hr	--	--	4.2	--	4.3	2.7	--
	mg/kg fuel	--	--	15	--	15	8.1	--
Acetylene	mg/hr	350	--	--	150	--	250	320
	mg/kW-hr	200	--	--	--	--	4.0	130
	mg/kg fuel	88	--	--	160	--	12	34
Propane	mg/hr	--	--	--	--	--	--	131
	mg/kW-hr	--	--	--	--	--	--	55
	mg/kg fuel	--	--	--	--	--	--	14
Propylene	mg/hr	1600	--	3600	--	--	3800	1600
	mg/kW-hr	900	--	39	--	--	60	670
	mg/kg fuel	400	--	140	--	--	180	170
Benzene	mg/hr	240	--	480	--	--	--	92
	mg/kW-hr	130	--	5.1	--	--	--	38
	mg/kg fuel	61	--	19	--	--	--	9.8

No toluene was detected.

TABLE D-35. SUMMARY OF ALDEHYDES FROM TRANSIENT OPERATION OF THE DDAD 6V-71N COACH ENGINE

Configuration	Transient Cycle	Units	Formaldehyde	Isobutyr-aldehyde	Benzaldehyde
Baseline	Cold Start	mg/test	190	180	33
		mg/kW-hr	27	25	4.7
		mg/kg	76	70	13
	Hot Start	mg/test	170	44	--
		mg/kW-hr	21	5.4	
		mg/kg	67	17	
	Bus	mg/test	--	40	--
		mg/kW-hr		12	
		mg/kg		36	
Maladjusted	Cold Start	mg/test	240	43	
		mg/kW-hr	28	5.0	
		mg/kg	79	14	
	Hot Start	mg/test	300	79	--
		mg/kW-hr	36	9.5	
		mg/kg	110	28	
	Bus	mg/test	--	--	--
		mg/kW-hr			
		mg/kg			

Note: No acetaldehyde

TABLE C-36. SUMMARY OF ALDEHYDES FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN BASELINE CONFIGURATION

		Test Condition, rpm/load, %						
Aldehyde	Units	1260 2	1260 50	1260 100	Idle	2100 100	2100 50	2100 2
Formaldehyde	μg/m^3 exh.	1600	960	2100	480	4700	870	760
	mg/hr	970	590	1300	85	4500	820	720
	mg/kW-hr	540	12	13	--	34	12	270
	mg/kg fuel	260	48	52	100	130	39	78
Acetaldehyde	μg/m^3 exh	220	230	150	--	820	--	--
	mg/hr	130	140	92	--	780	--	--
	mg/kW-hr	73	2.9	0.93	--	5.9	--	--
	mg/kg fuel	34	11	3.7	--	22	--	--
Isobutyraldehyde	μg/m^3 exh.	340	360	--	--	--	--	210
	mg/hr	210	220	--	--	--	--	200
	mg/kW-hr	120	4.5	--	--	--	--	74
	mg/kg fuel	56	18	--	--	--	--	22

No Benzaldehyde was noted for the baseline configuration.

TABLE C-37. SUMMARY OF ALDEHYDES FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN MALADJUSTED CONFIGURATION

Aldehyde	Units	Test Condition, rpm/load, % 1260 2	1260 50	1260 100	Idle	2100 100	2100 50	2100 2
Formaldehyde	$\mu g/m^3$ exh.	3100	800	2300	940	1500	1300	910
	mg/hr	1800	470	1400	160	1400	1200	820
	mg/kW-hr	1000	10	15	--	11	19	340
	mg/kg fuel	450	39	55	170	38	57	88
Acetaldehyde	$\mu g/m^3$ exh	1300	--	500	--	300	400	180
	mg/hr	760	--	290	--	280	370	160
	mg/kW-hr	430	--	3.1	--	2.2	5.9	67
	mg/kg fuel	190	--	11	--	7.7	17	17
Isobutyraldehyde	$\mu g/m^3$ exh.	--	500	--	--	150	380	2400
	mg/hr	--	290	--	--	140	340	2200
	mg/kW-hr	--	6.3	--	--	1.1	5.4	920
	mg/kg fuel	--	24	--	--	3.8	16	240

Benzaldehyde was emitted only during 1260 rpm/50 percent load at a level of 53 mg/hr

TABLE C-38. SUMMARY OF PHENOLS (FILTERED) FROM TRANSIENT OPERATION OF THE DDAD 6V-71N COACH ENGINE

Cycle Type	Unit	Phenol	Salicyl-aldehyde	m-cresol + p-cresol	5[a]	2,3,5-tri-methylphenol	2,3,5,6[b]	2npp[c]
Baseline	mg/test	--	--	--	--	--	--	130
Cold	mg/kW-hr	--	--	--	--	--	--	19
Start	mg/kg fuel	--	--	--	--	--	--	15
Baseline	mg/test	--	--	--	--	--	--	540
Hot	mg/kW-hr	--	--	--	--	--	--	64
Start	mg/kg fuel	--	--	--	--	--	--	210
Maladjusted	mg/test	--	--	--	--	5.6	--	94
Cold	mg/kW-hr	--	--	--	--	0.66	--	11
Start	mg/kg fuel	--	--	--	--	1.9	--	31
Maladjusted	mg/test	--	2400	650	--	17	15	160
Hot	mg/kW-hr	--	290	78	--	2.0	1.8	19
Start	mg/kg fuel	--	850	230	--	5.9	5.3	56

---

[a] p-ethylphenol, 2-isopropylphenol, 2,3-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol

[b] 2,4,5,6-tetramethylphenol

[c] 2-n-propylphenol

TABLE C-39. SUMMARY OF PHENOLS (FILTERED) FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN BASELINE CONFIGURATION

		Test Condition, rpm/load, %				
Phenol	Units	1260 2	1260 50	Idle	2100 100	2100 50
Phenol	$\mu g/m^3$ exh.	--	--	--	92	--
	mg/hr	--	--	--	88	--
	mg/kW-hr	--	--	--	0.67	--
	mg/kg fuel	--	--	--	2.5	--
Salicyl-aldehyde	$\mu g/m^3$ exh.	320	120	110	270	65
	mg/hr	190	73	19	260	61
	mg/kW-hr	110	1.5	--	2.0	0.93
	mg/kg fuel	50	6.0	23	7.3	2.9
m-cresol + P-cresol	$\mu g/m^3$ exh.	--	--	--	--	--
	mg/hr	--	--	--	--	--
	mg/kW-hr	--	--	--	--	--
	mg/kg fuel	--	--	--	--	--
5[a]	$\mu g/m^3$ exh.	6.1	--	--	--	--
	mg/hr	3.7	--	--	--	--
	mg/kW-hr	2.1	--	--	--	--
	mg/kg fuel	0.98	--	--	--	--
2,3,5-trimethyl phenol	$\mu g/m^3$ exh.	12	25	16	30	--
	mg/hr	7.3	15	2.8	29	--
	mg/kW-hr	4.1	0.30	--	0.22	--
	mg/kg fuel	1.9	1.2	3.3	0.81	--
2,3,5,6[b]	$\mu g/m^3$ exh.	--	--	--	--	--
	mg/hr	--	--	--	--	--
	mg/kW-hr	--	--	--	--	--
	mg/kg fuel	--	--	--	--	--
2 npp[c]	$\mu g/m^3$ exh.	240	59	87	130	59
	mg/hr	150	36	15	120	56
	mg/kW-hr	84	0.73	--	0.91	0.85
	mg/kg fuel	40	3.0	18	3.4	2.7

---

[a] p-ethylphenol, 2-isopropylphenol, 2,3-xypenol, 3,5-xylenol, 2,4,6-trimethylphenol

[b] 2,3,5,6-tetramethylphenol

[c] 2-n-propylphenol

TABLE C-40. SUMMARY OF PHENOLS (FILTERED) FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE IN MALADJUSTED CONFIGURATION

Phenol	Units	Test Condition, rpm/load, % 1260 2	1260 50	Idle	2100 100	2100 50
Phenol	μg/m³ exh.	--	--	--	--	--
	mg/hr	--	--	--	--	--
	mg/kW-hr	--	--	--	--	--
	mg/kg fuel	--	--	--	--	--
Salicyl-aldehyde	μg/m³ exh.	240	300	160	130	21
	mg/hr	140	180	27	120	19
	mg/kW-hr	79	3.9	--	0.95	0.30
	mg/kg fuel	35	15	28	3.3	0.90
m-cresol + P-cresol	μg/m³ exh.	20	--	--	--	--
	mg/hr	12	--	--	--	--
	mg/kW-hr	6.7	--	--	--	--
	mg/kg fuel	3.0	--	--	--	--
5[a]	μg/m³ exh.	20	--	--	6.6	--
	mg/hr	12	--	--	6.0	--
	mg/kW-hr	6.7	--	--	0.05	--
	mg/kg fuel	3.0	--	--	0.16	--
2,3,5-tri-methyl phenol	μg/m³ exh.	38	44	41	4.4	4.7
	mg/hr	22	26	7.0	4.0	4.3
	mg/kW-hr	12	0.57	--	0.03	0.07
	mg/kg fuel	5.6	2.2	7.3	0.11	0.20
2,3,5,6[b]	μg/m³ exh.	--	390	--	--	--
	mg/hr	--	230	--	--	--
	mg/kW-hr	--	5.0	--	--	--
	mg/kg fuel	--	19	--	--	--
2 npp[c]	μg/m³ exh.	870	1000	410	260	74
	mg/hr	510	590	70	240	67
	mg/kW-hr	290	13	--	1.9	1.1
	mg/kg fuel	130	49	73	6.6	3.2

---

[a] p-ethylphenol, 2-isopropylphenol, 2,3-xypenol, 3,5-xylenol, 2,4,6-trimethylphenol

[b] 2,3,5,6-tetramethylphenol

[c] 2-n-propylphenol

TABLE C-41. SUMMARY OF TIA FROM TRANSIENT OPERATION[a] OF THE DDAD 6V-71N IN BOTH TEST CONFIGURATIONS

Test Configuration	Transient Cycle	LCA µg/ℓ	TIA[b] LCA	LCO µg/ℓ	TIA[c] LCO
Baseline	Cold	144.	1.91	10.2	2.01
	Hot	93.9	1.78	3.66	1.56
	Composite	101.	1.80	4.59	1.66
Maladjusted	Cold	58.9	1.64	3.36	1.53
	Hot	72.1	1.70	3.54	1.55
	Composite	70.2	1.69	3.51	1.55

---

[a] Measurement during transient operation requires dilute exhaust sampling. The values given in this table are based on a nominal dilution ratio of 6:1.

[b] $TIA_{LCA} = 0.4 + 0.7$ (log LCA µg/ℓ)

[c] $TIA_{LCO} = 1.0 +$ log LCO µg/ℓ

Note: Highest value of TIA is generally taken to be representative of relative odor intensity.

TABLE C-42. SUMMARY OF TIA FROM MODAL OPERATION OF THE DDAD 6V-71N IN BOTH TEST CONFIGURATIONS

Test Condition rpm/load, %	Test Configuration	LCA µg/ℓ	TIA[a] LCA	LCO µg/ℓ	TIA[b] LCO
1260/2	Baseline	62.9	1.66	1.04	0.92
	Maladjusted	110.	1.83	5.18	1.70
1260/50	Baseline	71.3	1.70	0.78	0.79
	Maladjusted	115.	1.84	4.85	1.68
1260/100	Baseline	5.76	0.93	1.55	0.92
	Maladjusted	49.5	1.59	1.96	1.29
Idle	Baseline	26.4	1.39	1.49	1.17
	Maladjusted	37.7	1.50	0.55	0.81
2100/100	Baseline	69.4	1.69	4.56	1.66
	Maladjusted	64.0	1.66	4.66	1.67
2100/50	Baseline	74.2	1.71	3.17	1.50
	Maladjusted	35.3	1.48	2.16	1.33
2100/2	Baseline	103.	1.81	2.93	1.47
	Maladjusted	103.	1.81	3.50	1.53
7-Mode Composite	Baseline	43.9	1.55	1.58	1.20
	Maladjusted	63.1	1.66	2.45	1.39

---

[a] TIA_{LCA} = 0.4 + 0.7 (log LCA, µg/ℓ)

[b] TIA_{LCO} = 1.0 + log LCO, µg/ℓ

Note: Highest value of TIA is generally taken to be representative of relative odor intensity.

TABLE C-34. SUMMARY OF MODAL PARTICULATE EMISSIONS FROM THE DDAD 6V-71N

Test Condition rpm/load, %	Test Configuration	Particulate Rate			
		mg/m³ exh.	g/hr	g/kW-hr	g/kg fuel
1260/2	Baseline	12.45	7.54	4.21	2.00
	Maladjusted	11.48	6.72	3.78	1.70
1260/50	Baseline	22.27	13.59	0.28	1.12
	Maladjusted	25.67	15.08	0.33	1.26
1260/100	Baseline	161.46	98.93	1.01	3.96
	Maladjusted	661.88	389.60	4.20	15.40
Idle	Baseline	8.64	1.53	--	1.82
	Maladjusted	6.17	1.05	--	1.09
2100/100	Baseline	74.89	71.27	0.54	1.99
	Maladjusted	224.56	205.40	1.63	5.63
2100/50	Baseline	42.37	39.97	0.61	1.91
	Maladjusted	31.32	28.40	0.45	1.34
2100/2	Baseline	19,72	18.57	6.88	2.02
	Maladjusted	18.70	16.94	7.09	1.81

	Composite of 7-modes	
	Brake Specific, g/kW-hr	Fuel Specific, g/kg fuel
Baseline	0.70	2.27
Maladjusted	1.84	5.61

TABLE C-44. SULFATE EMISSION SUMMARY FROM TRANSIENT FTP OPERATION OF THE DDAD 6V-71N COACH ENGINE

Test Config.	Cycle Type	Sulfate Rate mg/test	Sulfate Rate mg/kW-hr	Sulfate Rate mg/kg fuel	$SO_4^=$ as % of Fuel S[a]
Baseline	Cold	190	28	75	1.4
	Hot	230	28	89	1.6
	Transient Composite	220	28	87	1.5
Maladjusted	Cold	190	22	63	1.2
	Hot	150	18	54	1.0
	Transient Composite	160	19	55	1.1

---

[a] No. 1 Diesel fuel has 0.18 percent by weight sulfur

TABLE C-45. SULFATE EMISSIONS SUMMARY FROM MODAL OPERATION OF THE DDAD 6V-71N COACH ENGINE

Test Condition rpm/load, %	Test Configuration	Sulfate Emission Rates mg/m^3 Exhaust	mg/hr	mg/kW-hr	mg/kg fuel	$SO_4^=$ as % of Fuel S[a]
1260/2	Baseline	0.40	240	130	63	1.2
	Maladjusted	0.43	250	140	63	1.2
1260/50	Baseline	1.4	880	18	72	1.3
	Maladjusted	1.3	800	17	67	1.2
1260/100	Baseline	2.4	1500	15	60	1.1
	Maladjusted	2.9	1700	18	67	1.2
Idle	Baseline	0.56	100	--	120	2.2
	Maladjusted	0.49	84	--	88	1.6
2100/100	Baseline	2.8	2700	21	76	1.4
	Maladjusted	2.3	2100	17	58	1.1
2100/50	Baseline	2.5	2400	36	110	2.0
	Maladjusted	2,2	2000	32	94	1.7
2100/2	Baseline	0.70	630	230	69	1.3
	Maladjusted	0.59	530	220	57	1.1

	Composite of 7-modes: Brake Specific, mg/kW-hr	Fuel Specific, mg/kg fuel
Baseline	24.8	80.6
Maladjsuted	23.0	69.9

---

[a] No. 1 Diesel Fuel has 0.18 percent by weight sulfur.

TABLE C-46. SUMMARY OF SOLUBLE ORGANIC FRACTION FROM THE DDAD 6V-71N

Test Condition rpm/load, %	Modal Soluble Organic Fraction			
	Baseline		Maladjusted	
	% SOF	g SOF/hr	% SOF	g SOF/hr
1260/2	83.3	6.28	78.9	5.31
1260/50	53.0	7.20	54.5	8.22
1260/100	14.5	14.3	3.37	13.1
Idle	56.4	0.864	52.4	0.550
2100/100	20.9	14.9	7.85	16.1
2100/50	35.2	14.1	40.8	11.6
2100/2	69.5	12.9	60.0	10.1

APPENDIX D

DISCUSSION OF FILTERED AND UNFILTERED BUS CYCLE AND EMISSION RESULTS FROM THREE GMC RTS II TYPE 4 BUSES

ATTACHMENT D-1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE May 27, 1983

SUBJECT New York Bus Cycle

FROM Frank Black (MD-46) Frank

TO Tom Baines
EPA, Ann Arbor

As discussed during our recent telephone conversation, MSERB is examining emissions from heavy duty truck and buses at SWRI using chassis transient test procedures. Harry Dietzmann suggested we consider testing the buses using a transient cycle that you provided for one of the AA projects at SWRI. After examining the cycle, we question whether a bus can follow the rapid speed fluctions.

We have developed a process permitting examination of the acceleration-deceleration characteristics of a cycle and smoothing to the limits of the vehicles being examined. The process requires examination of actual vehicle speed-time traces to determine the frequencies associated with meaningful vehicle speed changes. The speed-time data is examined in the frequency domain by using available Fourier Transform techniques. With the meaningful frequencies identified, all higher frequencies in the cycle Transform listing are filtered (set to zero), and the reverse Transform generated to define the "smoothed" cycle. Examples of this process are attached. Figure 1 illustrates the original bus cycle. There is a great deal of speed "dither," near impossible for a bus to follow. Attached to this figure is an illustration of acceleration values (+) and deceleration values (-) as a function of speed associated with this cycle. Only integer values appear, not at all typical of real driving. Figure 2 is a smoothed version of this cycle filtered at 0.15 Hz. The distance traveled and average speed are the same as the original cycle, but the acceleration-deceleration characteristics are dramatically changed.

Figure 3 illustrates acceleration-deceleration rates as a function of time for both versions of the cycle. The original cycle requires the driver to go from wide-open throttle to stand-on-the-brake and back again, very often, in very short periods of time. Buses aren't driven this way, obviously. Figures 4 and 5 illustrate the speed-time traces for the original and smoothed cycles with the permitted speed tolerances of the original cycle. The smoothed cycle speeds are within the permitted range of the original cycle speeds.

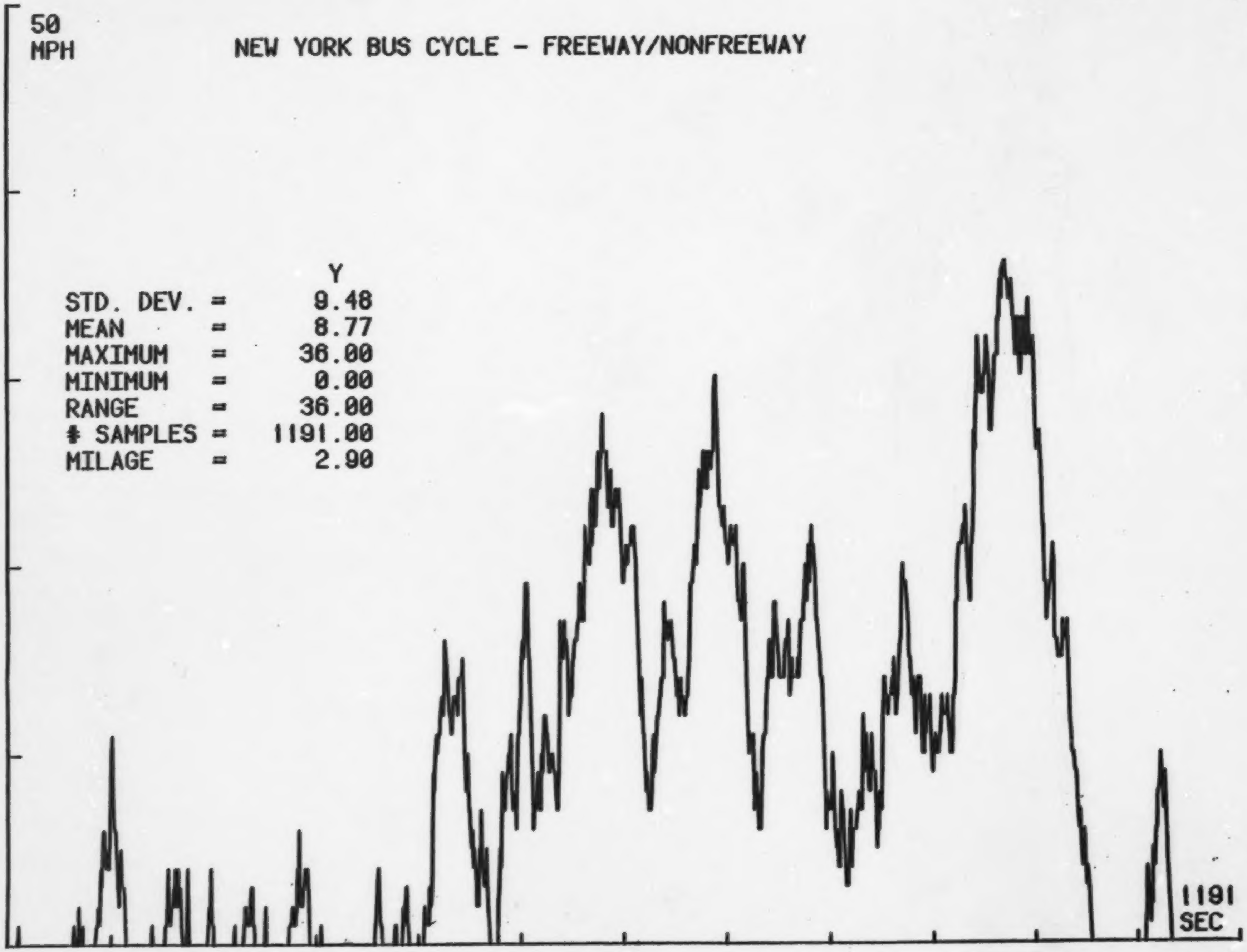
If we examine emissions with this cycle in the SWRI project, I would be inclined to use a smoothed version. Do you have any of the original bus speed time data on which the cycle was based? An alternative would be to use an actual bus over-the-road schedule.

Your comments would be appreciated.

Enclosures

EPA Form 1320-6 (Rev. 3-76)

figure 1


NEW YORK BUS CYCLE - FREEWAY/NONFREEWAY
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MPH
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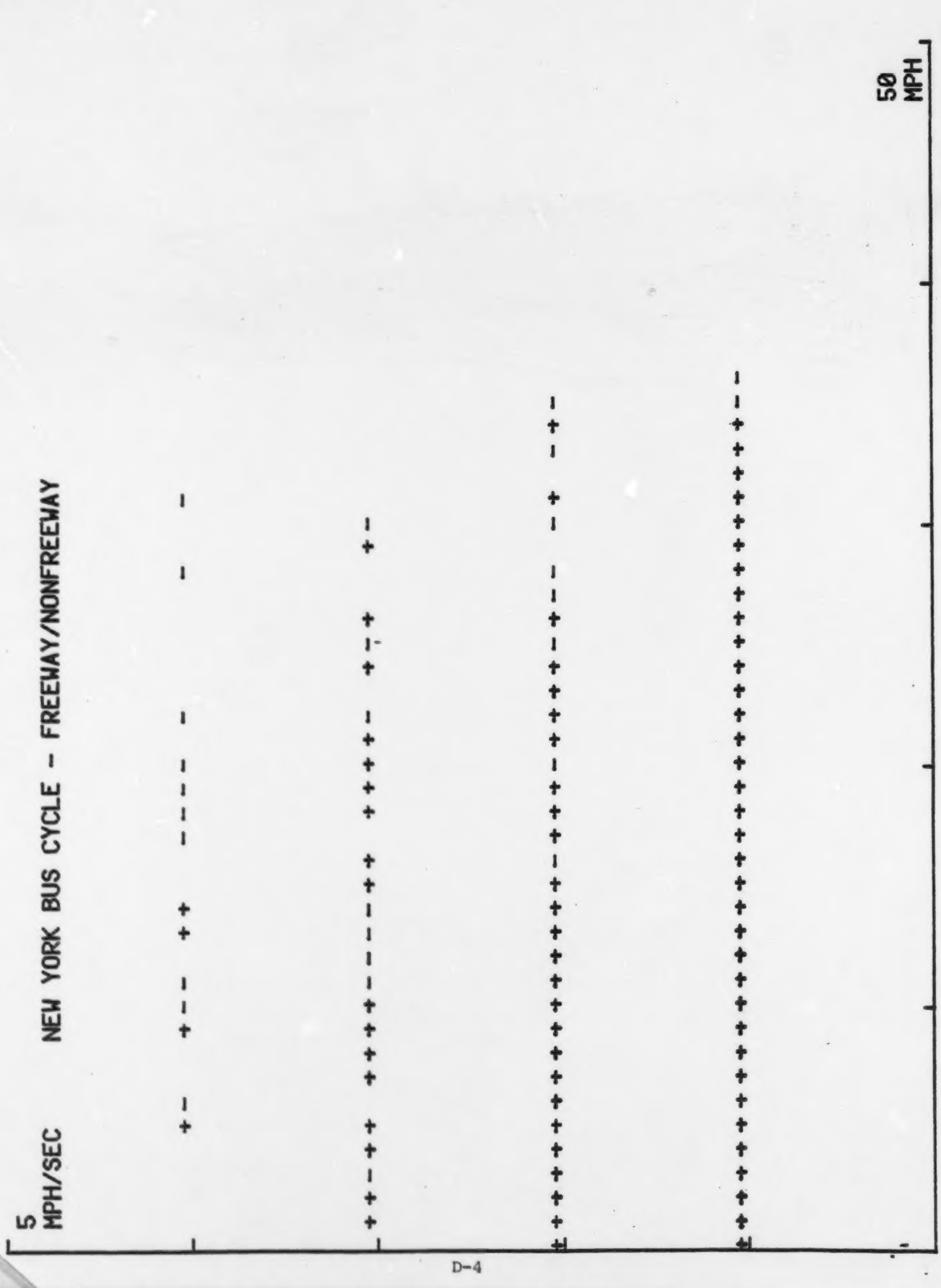
STD. DEV. = 9.48
MEAN = 8.77
MAXIMUM = 36.00
MINIMUM = 0.00
RANGE = 36.00
# SAMPLES = 1191.00
MILAGE = 2.90
1191
SEC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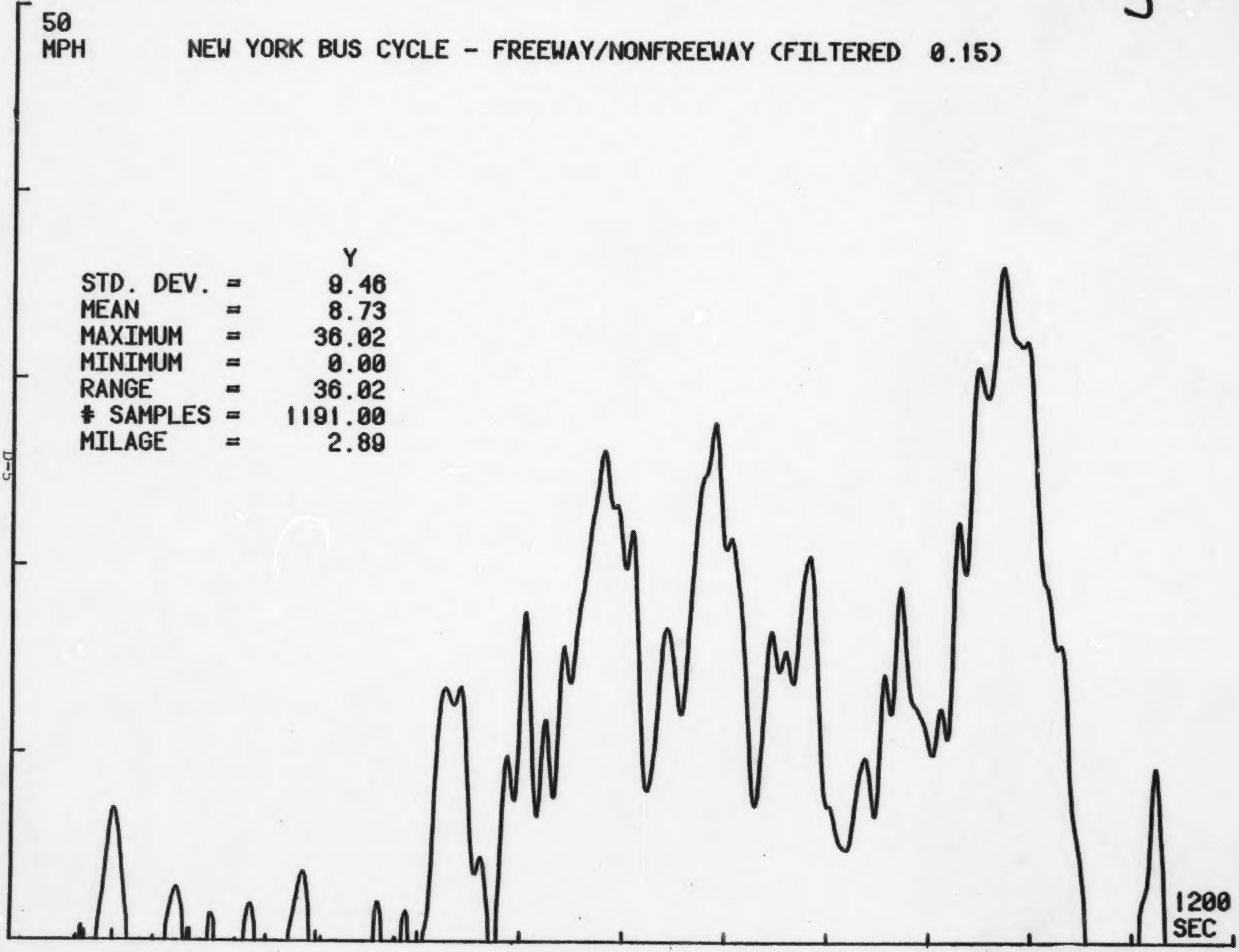
MPH/SEC
NEW YORK BUS CYCLE - FREEWAY/NONFREEWAY
50
MPH

figure 2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MPH
NEW YORK BUS CYCLE - FREEWAY/NONFREEWAY (FILTERED 0.15)
Y
STD. DEV. = 9.46
MEAN = 8.73
MAXIMUM = 36.02
MINIMUM = 0.00
RANGE = 36.02
# SAMPLES = 1191.00
MILAGE = 2.89
1200
SEC

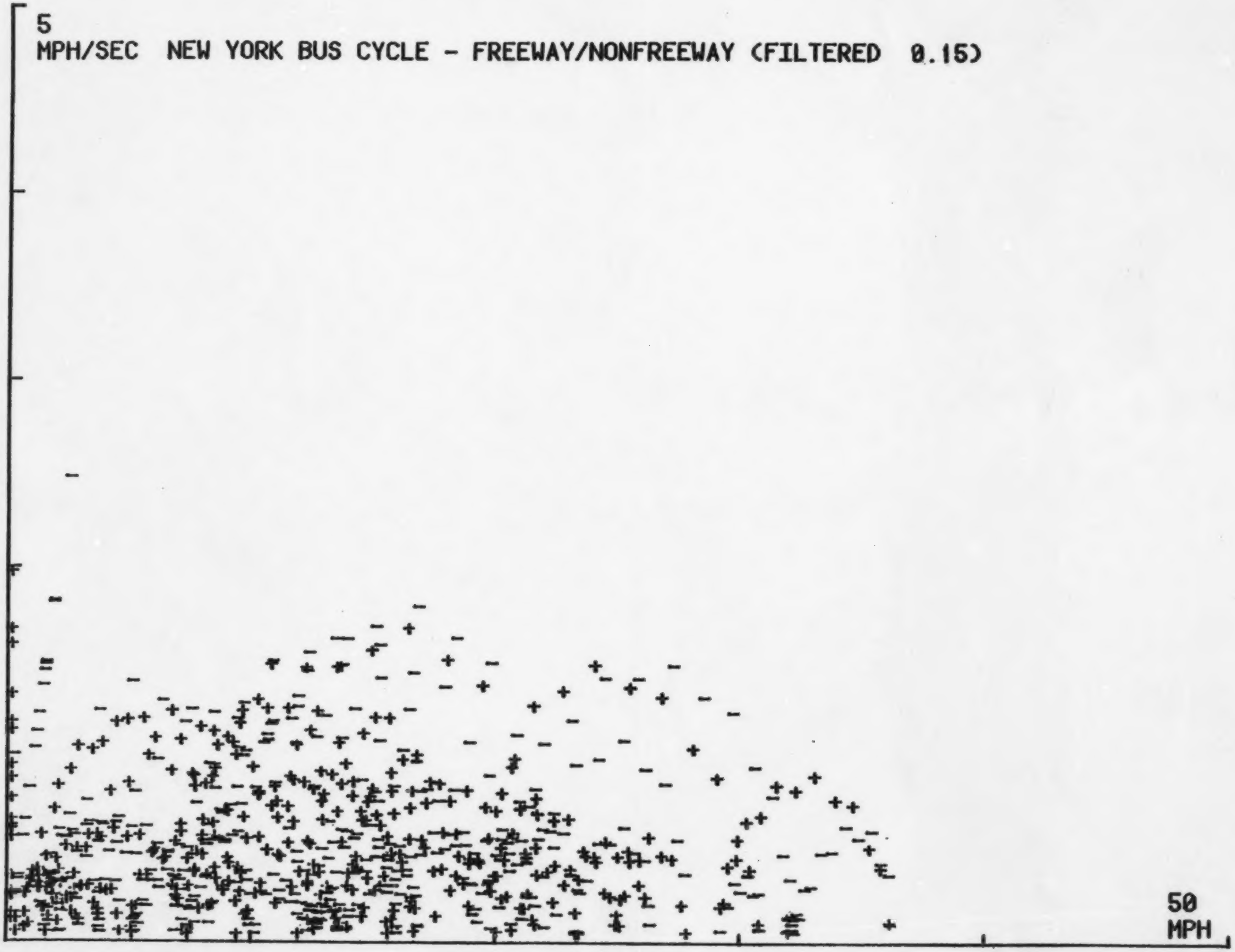
5
MPH/SEC NEW YORK BUS CYCLE - FREEWAY/NONFREEWAY (FILTERED 0.15)
50
MPH

TABLE D-1. C-TRAN VEHICLE EMISSIONS RESULTS

```
                                        PROJECT 03-5428-001

TEST NO.   1        RUN   1                VEHICLE NO. 2162              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE    11/29/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1               DIESEL     EM-597-F
TRANSMISSION A-3                           DYNO NO.      4               ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 738.89 MM HG(29.09 IN HG)        DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
RELATIVE HUMIDITY  39. PCT                 ABS. HUMIDITY  6.6 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .93
BAG RESULTS
  BAG NUMBER                                   1                  2                  3                  4
  DESCRIPTION                                NYNF               LANF                LAF               NYNF

  RUN TIME                  SECONDS          254.0              285.0              267.0              262.0
  TOT. BLOWER RATE SCMM (SCFM)         256.10 ( 9042.9)   255.37 ( 9017.2)   255.39 ( 9017.9)   255.32 ( 9015.5)
  TOT. 20X20 RATE SCMM (SCFM)            3.24 (114.3)       3.24 (114.3)       3.24 (114.3)       3.24 (114.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)       .04 ( 1.25)        .04 ( 1.25)        .04 ( 1.25)        .04 ( 1.25)
  TOT FLOW STD. CU. METRES(SCF)        1098.0 ( 38771.)   1228.6 ( 43381.)   1151.1 ( 40644.)   1129.2 ( 39872.)

  HC   SAMPLE METER/RANGE/PPM            9.6/21/ 4.82       9.7/21/ 4.83      13.7/21/ 6.85       8.6/21/ 4.31
  HC   BCKGRD METER/RANGE/PPM            6.5/ 1/ 3.25       6.0/ 1/ 3.00       5.5/ 1/ 2.75       5.0/ 1/ 2.50
  CO   SAMPLE METER/RANGE/PPM           27.3/13/24.94      21.5/13/19.50      10.4/13/ 9.31      18.2/13/16.44
  CO   BCKGRD METER/RANGE/PPM            1.1/13/  .97       1.1/13/  .97       1.1/13/  .97       1.1/13/  .97
  CO2  SAMPLE METER/RANGE/PCT           70.6/13/.1443      76.9/13/.1592      78.6/12/.3371      59.7/13/.1197
  CO2  BCKGRD METER/RANGE/PCT           20.9/13/.0384      20.7/13/.0380      11.6/12/.0393      19.8/13/.0362
  NOX  SAMPLE METER/RANGE/PPM           35.5/ 1/10.55      43.1/ 1/12.81      99.6/ 1/29.62      36.6/ 1/10.88
  NOX  BCKGRD METER/RANGE/PPM             .3/ 1/  .08        .4/ 1/  .11        .8/ 1/  .23        .7/ 1/  .20
  DILUTION FACTOR                          91.04              82.93              39.56             110.08

  HC   CONCENTRATION PPM                    1.60               1.86               4.17               1.84
  CO   CONCENTRATION PPM                   23.60              18.25               8.19              15.25
  CO2  CONCENTRATION PCT                   .1063              .1216              .2988              .0838
  NOX  CONCENTRATION PPM                   10.47              12.70              29.40              10.68
  HC   MASS GRAMS                          1.016              1.319              2.767              1.196
  CO   MASS GRAMS                         30.172             26.097             10.981             20.041
  CO2  MASS GRAMS                        2136.77            2736.12            6297.82            1732.20
  NOX  MASS GRAMS                         20.472             27.787             60.244             21.474
  MASS OF FUEL BURNED GRAMS               686.87             873.37            1985.77             555.02
  MEASURED DISTANCE  KM (MILES)       .827 ( .514)      1.901 (1.182)      5.457 (3.391)       .873 ( .542)
  FUEL ECONOMY  L/100KM (MPG)        98.15 ( 2.397)     54.29 ( 4.333)     43.01 ( 5.469)     75.18 ( 3.129)

  HC    GRAMS/KM (GRAMS/MILE)         1.23 (  1.98)       .69 (  1.12)       .51 (   .82)      1.37 (  2.21)
  CO    GRAMS/KM (GRAMS/MILE)        36.48 ( 58.70)     13.73 ( 22.09)      2.01 (  3.24)     22.97 ( 36.96)
  CO2   GRAMS/KM (GRAMS/MILE)       2583.5 (4156.8)    1439.1 (2315.6)    1154.2 (1857.0)    1985.3 (3194.4)
  NOX   GRAMS/KM (GRAMS/MILE)        24.75 ( 39.83)     14.62 ( 23.52)     11.04 ( 17.76)     24.61 ( 39.60)

                                     C-TRAN COMPOSITE RESULTS
             HC    GRAMS/KM (GRAMS/MILE)      .70 ( 1.12)                 PARTICULATE RATE
             CO    GRAMS/KM (GRAMS/MILE)     9.64 ( 15.51)                GRAMS/TEST        16.142
             CO2   GRAMS/KM (GRAMS/MILE)  1424.57 (2292.13)               GRAMS/KG FUEL      3.94
             NOX   GRAMS/KM (GRAMS/MILE)    14.35 (23.09)                 GRAMS/KM           1.78
                                                                          GRAMS/MILE         2.87

             TOTAL DISTANCE  KM (MILES)     9.057 ( 5.63)
             FUEL CONSUMPTION  KG (LB)      4.101 ( 9.043)                FILTER EFF.       87.80
             FUEL ECONOMY  L/100KM (MPG)   53.52 ( 4.40)
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TABLE D-1. C-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)

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                                                  PROJECT 03-5428-001

TEST NO.    1        RUN    1                  VEHICLE NO. 2162                    TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    11/29/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                     DIESEL     EM-597-F
TRANSMISSION A-3                               DYNO NO.      4                     ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 738.89 MM HG(29.09 IN HG)            DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
RELATIVE HUMIDITY  39. PCT                     ABS. HUMIDITY  6.6 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .93
BAG RESULTS
  BAG NUMBER                                        1                  2                  3                  4
  DESCRIPTION                                     NYNF               LANF                LAF               NYNF

  RUN TIME                    SECONDS             254.0              285.0              267.0              262.0
  TOT. BLOWER RATE SCMM (SCFM)               256.10 ( 9042.9)   255.37 ( 9017.2)   255.39 ( 9017.9)   255.32 ( 9015.5)
  TOT. 20X20 RATE SCMM (SCFM)                  3.24 (114.3)       3.24 (114.3)       3.24 (114.3)       3.24 (114.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .04 ( 1.25)        .04 ( 1.25)        .04 ( 1.25)        .04 ( 1.25)
  TOT FLOW STD. CU. METRES(SCF)             1098.0 ( 38771.)   1228.6 ( 43381.)   1151.1 ( 40644.)   1129.2 ( 39872.)

  HC   SAMPLE METER/RANGE/PPM                  9.6/21/ 4.82       9.7/21/ 4.83      13.7/21/ 6.85       8.6/21/ 4.31
  HC   BCKGRD METER/RANGE/PPM                  6.5/ 1/ 3.25       6.0/ 1/ 3.00       5.5/ 1/ 2.75       5.0/ 1/ 2.50
  CO   SAMPLE METER/RANGE/PPM                 27.3/13/24.94      21.5/13/19.50      10.4/13/ 9.31      18.2/13/16.44
  CO   BCKGRD METER/RANGE/PPM                  1.1/13/  .97       1.1/13/  .97       1.1/13/  .97       1.1/13/  .97
  CO2  SAMPLE METER/RANGE/PCT                 70.6/13/.1443      76.9/13/.1592      78.6/12/.3371      59.7/13/.1197
  CO2  BCKGRD METER/RANGE/PCT                 20.9/13/.0384      20.7/13/.0380      11.6/12/.0393      19.8/13/.0362
  NOX  SAMPLE METER/RANGE/PPM                 11.8/12/11.85      14.7/12/14.70      33.5/12/33.49      12.1/12/12.09
  NOX  BCKGRD METER/RANGE/PPM                   .3/ 1/  .08        .4/ 1/  .11        .8/ 1/  .23        .7/ 1/  .20
  DILUTION FACTOR                                  91.04              82.93              39.56             110.08

  HC   CONCENTRATION PPM                            1.60               1.86               4.17               1.84
  CO   CONCENTRATION PPM                           23.60              18.25               8.19              15.25
  CO2  CONCENTRATION PCT                           .1063              .1216              .2988              .0838
  NOX  CONCENTRATION PPM                           11.77              14.59              33.27              11.89
  HC   MASS GRAMS                                  1.016              1.319              2.767              1.196
  CO   MASS GRAMS                                 30.172             26.097             10.981             20.041
  CO2  MASS GRAMS                                2136.77            2736.12            6297.82            1732.20
  NOX  MASS GRAMS                                 23.005             31.919             68.174             23.909
  MASS OF FUEL BURNED GRAMS                       686.87             873.37            1985.77             555.02
  MEASURED DISTANCE  KM (MILES)                .827 ( .514)      1.901 (1.182)      5.457 (3.391)       .873 ( .542)
  FUEL ECONOMY  L/100KM (MPG)                98.15 ( 2.397)     54.29 ( 4.333)     43.01 ( 5.469)     75.18 ( 3.129)

  HC    GRAMS/KM (GRAMS/MILE)                 1.23 (  1.98)       .69 (  1.12)       .51 (   .82)      1.37 (  2.21)
  CO    GRAMS/KM (GRAMS/MILE)                36.48 ( 58.70)     13.73 ( 22.09)      2.01 (  3.24)     22.97 ( 36.96)
  CO2   GRAMS/KM (GRAMS/MILE)               2583.5 (4156.8)    1439.1 (2315.6)    1154.2 (1857.0)    1985.3 (3194.4)
  NOX   GRAMS/KM (GRAMS/MILE)                27.81 ( 44.75)     16.79 ( 27.01)     12.49 ( 20.10)     27.40 ( 44.09)

                                         C-TRAN COMPOSITE RESULTS
                 HC    GRAMS/KM (GRAMS/MILE)       .70 ( 1.12)                    PARTICULATE RATE
                 CO    GRAMS/KM (GRAMS/MILE)      9.64 ( 15.51)                   GRAMS/TEST       16.142
                 CO2   GRAMS/KM (GRAMS/MILE)   1424.57 (2292.13)                  GRAMS/KG FUEL     3.94
   CONTINUOUS    NOX   GRAMS/KM (GRAMS/MILE)     16.23 (26.12)                    GRAMS/KM          1.78
                                                                                  GRAMS/MILE        2.87

                 TOTAL DISTANCE  KM (MILES)      9.057 ( 5.63)
                 FUEL CONSUMPTION  KG (LB)       4.101 ( 9.043)                   FILTER EFF.     87.80
                 FUEL ECONOMY  L/100KM (MPG)     53.52 ( 4.40)
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                                TABLE D-2. C-TRAN VEHICLE EMISSIONS RESULTS
                                              PROJECT 03-5428-001

TEST NO.   2        RUN   1                VEHICLE NO. 2162              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE    11/30/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1               DIESEL     EM-597-F
TRANSMISSION A-3                           DYNO NO.      4               ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 743.20 MM HG(29.26 IN HG)        DRY BULB TEMP. 18.3 DEG C(65.0 DEG F)
RELATIVE HUMIDITY  32. PCT                 ABS. HUMIDITY  4.3 GM/KG      NOX HUMIDITY CORRECTION FACTOR   .90
BAG RESULTS
  BAG NUMBER                                     1              2              3              4
  DESCRIPTION                                  NYNF           LANF            LAF           NYNF

  RUN TIME                 SECONDS             254.0          285.0          265.0          262.0
  TOT. BLOWER RATE SCMM (SCFM)           255.73 ( 9029.9)  255.64 ( 9026.5)  257.69 ( 9099.0)  255.55 ( 9023.3)
  TOT. 20X20 RATE SCMM (SCFM)              3.26 (115.3)      3.26 (115.3)      3.26 (115.3)      3.26 (115.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)         .04 ( 1.26)       .04 ( 1.26)       .04 ( 1.26)       .04 ( 1.26)
  TOT FLOW STD. CU. METRES(SCF)          1096.6 ( 38720.)  1230.0 ( 43430.)  1152.7 ( 40702.)  1130.3 ( 39911.)

  HC  SAMPLE METER/RANGE/PPM               10.0/21/ 5.02    11.3/21/ 5.66    17.0/21/ 8.50    12.4/21/ 6.18
  HC  BCKGRD METER/RANGE/PPM                7.0/ 1/ 3.50     7.5/ 1/ 3.75     8.0/ 1/ 4.00     8.5/ 1/ 4.25
  CO  SAMPLE METER/RANGE/PPM               21.9/13/19.87    16.8/13/15.15     8.6/13/ 7.68    14.1/13/12.68
  CO  BCKGRD METER/RANGE/PPM                 .6/13/  .53      .6/13/  .53      .6/13/  .53      .4/13/  .35
  CO2 SAMPLE METER/RANGE/PCT               66.4/13/.1346    75.2/13/.1551    77.4/12/.3306    59.3/13/.1188
  CO2 BCKGRD METER/RANGE/PCT               20.9/13/.0384    20.9/13/.0384    11.8/12/.0400    20.6/13/.0378
  NOX SAMPLE METER/RANGE/PPM               35.6/ 1/10.58    45.4/ 1/13.50    31.9/ 2/31.90    37.8/ 1/11.24
  NOX BCKGRD METER/RANGE/PPM                 .6/ 1/  .17     1.0/ 1/  .29      .5/ 2/  .50      .6/ 1/  .17
  DILUTION FACTOR                              97.74          85.27          40.34         111.05

  HC  CONCENTRATION PPM                         1.55           1.95           4.60           1.97
  CO  CONCENTRATION PPM                        19.09          14.43           7.04          12.17
  CO2 CONCENTRATION PCT                        .0966          .1171          .2916          .0813
  NOX CONCENTRATION PPM                        10.41          13.21          31.41          11.07
  HC  MASS GRAMS                                .982          1.385          3.060          1.285
  CO  MASS GRAMS                              24.376         20.662          9.448         16.012
  CO2 MASS GRAMS                             1940.23        2637.97        6153.43        1683.36
  NOX MASS GRAMS                              19.554         27.826         62.003         21.422
  MASS OF FUEL BURNED GRAMS                   622.26         839.93        1939.97         537.78
  MEASURED DISTANCE  KM (MILES)          .822 ( .511)   1.871 (1.163)   5.402 (3.357)    .855 ( .532)
  FUEL ECONOMY  L/100KM (MPG)           89.52 ( 2.628)  53.06 ( 4.433)  42.45 ( 5.542)  74.31 ( 3.165)

  HC    GRAMS/KM (GRAMS/MILE)            1.20 (  1.92)    .74 (  1.19)    .57 (   .91)   1.50 (  2.42)
  CO    GRAMS/KM (GRAMS/MILE)           29.67 ( 47.74)  11.04 ( 17.77)   1.75 (  2.81)  18.72 ( 30.12)
  CO2   GRAMS/KM (GRAMS/MILE)          2361.6 (3799.8) 1410.0 (2268.6) 1139.2 (1833.0) 1968.1 (3166.7)
  NOX   GRAMS/KM (GRAMS/MILE)           23.80 ( 38.30)  14.87 ( 23.93)  11.48 ( 18.47)  25.05 ( 40.30)

                                   C-TRAN COMPOSITE RESULTS
          HC    GRAMS/KM (GRAMS/MILE)      .75 ( 1.21)                 PARTICULATE RATE
          CO    GRAMS/KM (GRAMS/MILE)     7.88 ( 12.67)                GRAMS/TEST       17.826
          CO2   GRAMS/KM (GRAMS/MILE)  1387.24 (2232.08)               GRAMS/KG FUEL     4.52
          NOX   GRAMS/KM (GRAMS/MILE)    14.62 (23.52)                 GRAMS/KM          1.99
                                                                       GRAMS/MILE        3.20

          TOTAL DISTANCE  KM (MILES)     8.949 ( 5.56)
          FUEL CONSUMPTION  KG (LB)      3.940 ( 8.688)                FILTER EFF.     95.66
          FUEL ECONOMY  L/100KM (MPG)    52.03 ( 4.52)
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D-2 cont'd

TABLE D-2. C-TRAN VEHICLE EMISSIONS RESULTS (Cont'd).

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                                    PROJECT 03-5428-001
TEST NO.   2        RUN   1
VEHICLE MODEL 1983 GMC RTSII 04         VEHICLE NO. 2162                  TEST WEIGHT 13608. KG(30000. LBS)
ENGINE   9.0 L( 552. CID) V-6           DATE    11/30/84                  ACTUAL ROAD LOAD   58.4 KW( 78.3 HP)
TRANSMISSION A-3                        BAG CART NO.  1                   DIESEL     EM-597-F
GVW16738. KG(36900. LBS)                DYNO NO.      4                   ODOMETER  88619. KM( 55065. MILES)
                                        CVS NO.      11

BAROMETER 743.20 MM HG(29.26 IN HG)     DRY BULB TEMP. 18.3 DEG C(65.0 DEG F)
RELATIVE HUMIDITY  32. PCT              ABS. HUMIDITY  4.3 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .90
BAG RESULTS
  BAG NUMBER                                  1                 2                 3                 4
  DESCRIPTION                               NYNF              LANF               LAF              NYNF

  RUN TIME                    SECONDS       254.0             285.0             265.0             262.0
  TOT. BLOWER RATE SCMM (SCFM)         255.73 ( 9029.9)  255.64 ( 9026.5)  257.69 ( 9099.0)  255.55 ( 9023.3)
  TOT. 20X20 RATE SCMM (SCFM)            3.26 (115.3)      3.26 (115.3)      3.26 (115.3)      3.26 (115.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)       .04 ( 1.26)       .04 ( 1.26)       .04 ( 1.26)       .04 ( 1.26)
  TOT FLOW STD. CU. METRES(SCF)        1096.6 ( 38720.)  1230.0 ( 43430.)  1152.7 ( 40702.)  1130.3 ( 39911.)

  HC   SAMPLE METER/RANGE/PPM           10.0/21/ 5.02     11.3/21/ 5.66     17.0/21/ 8.50     12.4/21/ 6.18
  HC   BCKGRD METER/RANGE/PPM            7.0/ 1/ 3.50      7.5/ 1/ 3.75      8.0/ 1/ 4.00      8.5/ 1/ 4.25
  CO   SAMPLE METER/RANGE/PPM           21.9/13/19.87     16.8/13/15.15      8.6/13/ 7.68     14.1/13/12.68
  CO   BCKGRD METER/RANGE/PPM             .6/13/  .53       .6/13/  .53       .6/13/  .53       .4/13/  .35
  CO2  SAMPLE METER/RANGE/PCT           66.4/13/.1346     75.2/13/.1551     77.4/12/.3306     59.3/13/.1188
  CO2  BCKGRD METER/RANGE/PCT           20.9/13/.0384     20.9/13/.0384     11.8/12/.0400     20.6/13/.0378
  NOX  SAMPLE METER/RANGE/PPM           11.0/12/11.00     13.9/12/13.89     33.7/12/33.69     11.2/12/11.16
  NOX  BCKGRD METER/RANGE/PPM             .6/ 1/  .17      1.0/ 1/  .29       .5/ 2/  .50       .6/ 1/  .17
  DILUTION FACTOR                          97.74             85.27             40.34            111.05

  HC   CONCENTRATION PPM                    1.55              1.95              4.60              1.97
  CO   CONCENTRATION PPM                   19.09             14.43              7.04             12.17
  CO2  CONCENTRATION PCT                   .0966             .1171             .2916             .0813
  NOX  CONCENTRATION PPM                   10.83             13.61             33.20             10.99
  HC   MASS GRAMS                           .982             1.385             3.060             1.285
  CO   MASS GRAMS                         24.376            20.662             9.448            16.012
  CO2  MASS GRAMS                        1940.23           2637.97           6153.43           1683.36
  NOX  MASS GRAMS                         20.335            28.661            65.537            21.267
  MASS OF FUEL BURNED GRAMS               622.26            839.93           1939.97            537.78
  MEASURED DISTANCE  KM (MILES)        .822 ( .511)     1.871 (1.163)     5.402 (3.357)      .855 ( .532)
  FUEL ECONOMY  L/100KM (MPG)        89.52 ( 2.628)    53.06 ( 4.433)    42.45 ( 5.542)    74.31 ( 3.165)

  HC    GRAMS/KM (GRAMS/MILE)         1.20 (  1.92)      .74 (  1.19)      .57 (   .91)     1.50 (  2.42)
  CO    GRAMS/KM (GRAMS/MILE)        29.67 ( 47.74)    11.04 ( 17.77)     1.75 (  2.81)    18.72 ( 30.12)
  CO2   GRAMS/KM (GRAMS/MILE)       2361.6 (3799.8)   1410.0 (2268.6)   1139.2 (1833.0)   1968.1 (3166.7)
  NOX   GRAMS/KM (GRAMS/MILE)        24.75 ( 39.82)    15.32 ( 24.65)    12.13 ( 19.52)    24.86 ( 40.01)

                                          C-TRAN COMPOSITE RESULTS
              HC   GRAMS/KM (GRAMS/MILE)     .75 ( 1.21)
              CO   GRAMS/KM (GRAMS/MILE)    7.88 ( 12.67)              PARTICULATE RATE
              CO2  GRAMS/KM (GRAMS/MILE) 1387.24 (2232.08)             GRAMS/TEST       17.826
  CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)   15.17 (24.42)               GRAMS/KG FUEL     4.52
                                                                       GRAMS/KM          1.99
                                                                       GRAMS/MILE        3.20
              TOTAL DISTANCE  KM (MILES)       8.949 ( 5.56)
              FUEL CONSUMPTION  KG (LB)        3.940 ( 8.688)          FILTER EFF.      95.66
              FUEL ECONOMY  L/100KM (MPG)     52.03 ( 4.52)
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TABLE D-3. H-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

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TEST NO.   1        RUN   1
VEHICLE MODEL 1983 GMC RTSII 04                VEHICLE NO. 2162
ENGINE  9.0 L( 552. CID) V-6                   DATE    11/29/84               TEST WEIGHT 13608. KG(30000. LBS)
TRANSMISSION A-3                               BAG CART NO.  1                ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
GVW16738. KG(36900. LBS)                       DYNO NO.      4                DIESEL     EM-597-F
                                               CVS NO.      11                ODOMETER  88619. KM( 55065. MILES)

BAROMETER 739.39 MM HG(29.11 IN HG)            DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
RELATIVE HUMIDITY  42. PCT                     ABS. HUMIDITY  7.2 GM/KG
BAG RESULTS                                                                   NOX HUMIDITY CORRECTION FACTOR   .94
   BAG NUMBER                                       1                  2                  3                  4
   DESCRIPTION                                     NYNF               LANF               LAF                NYNF

   RUN TIME                    SECONDS            254.0              285.0              267.0              262.0
   TOT. BLOWER RATE SCMM (SCFM)               255.28 ( 9013.9)   255.27 ( 9013.7)   255.34 ( 9016.0)   255.25 ( 9012.8)
   TOT. 20X20 RATE SCMM (SCFM)                  3.25 (114.7)       3.25 (114.7)       3.25 (114.7)       3.25 (114.7)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 ( 1.23)        .03 ( 1.23)        .03 ( 1.23)        .03 ( 1.23)
   TOT FLOW STD. CU. METRES(SCF)             1094.6 ( 38649.)   1228.1 ( 43366.)   1150.9 ( 40637.)   1128.9 ( 39862.)

   HC   SAMPLE METER/RANGE/PPM                  8.8/21/ 4.42      10.1/21/ 5.03      14.3/21/ 7.15      10.1/21/ 5.06
   HC   BCKGRD METER/RANGE/PPM                  5.0/ 1/ 2.50       5.5/ 1/ 2.75       6.0/ 1/ 3.00       6.5/ 1/ 3.25
   CO   SAMPLE METER/RANGE/PPM                 21.7/13/19.69      15.7/13/14.14       8.4/13/ 7.50      14.7/13/13.22
   CO   BCKGRD METER/RANGE/PPM                   .6/13/  .53        .5/13/  .44       1.0/13/  .89        .9/13/  .80
   CO2  SAMPLE METER/RANGE/PCT                 59.6/13/.1195      70.7/13/.1445      75.2/12/.3187      56.8/13/.1133
   CO2  BCKGRD METER/RANGE/PCT                 20.1/13/.0368      19.9/13/.0364      11.3/12/.0382      19.7/13/.0360
   NOX  SAMPLE METER/RANGE/PPM                 34.5/ 1/10.26      42.8/ 1/12.72      94.9/ 1/28.22      34.1/ 1/10.14
   NOX  BCKGRD METER/RANGE/PPM                   .5/ 1/  .14        .5/ 1/  .14       1.3/ 1/  .38       1.1/ 1/  .32
   DILUTION FACTOR                                109.98             91.54              41.85             116.39

   HC   CONCENTRATION PPM                           1.94               2.31               4.22               1.83
   CO   CONCENTRATION PPM                          18.85              13.48               6.50              12.24
   CO2  CONCENTRATION PCT                          .0830              .1085              .2814              .0776
   NOX  CONCENTRATION PPM                          10.12              12.59              27.85               9.82
   HC   MASS GRAMS                                 1.227              1.634              2.799              1.194
   CO   MASS GRAMS                                24.024             19.269              8.709             16.082
   CO2  MASS GRAMS                               1662.98            2438.90            5929.32            1604.01
   NOX  MASS GRAMS                                19.917             27.802             57.661             19.941
   MASS OF FUEL BURNED GRAMS                      535.28             776.98            1868.97             512.81
   MEASURED DISTANCE  KM (MILES)              .866 ( .538)      1.894 (1.177)      5.476 (3.403)       .891 ( .554)
   FUEL ECONOMY  L/100KM (MPG)               73.03 ( 3.221)     48.48 ( 4.853)     40.34 ( 5.831)     68.02 ( 3.458)

   HC    GRAMS/KM (GRAMS/MILE)                1.42 (  2.28)       .86 (  1.39)       .51 (   .82)      1.34 (  2.16)
   CO    GRAMS/KM (GRAMS/MILE)               27.73 ( 44.62)     10.17 ( 16.37)      1.59 (  2.56)     18.05 ( 29.04)
   CO2   GRAMS/KM (GRAMS/MILE)              1919.6 (3088.6)    1287.5 (2071.5)    1082.8 (1742.2)    1800.1 (2896.3)
   NOX   GRAMS/KM (GRAMS/MILE)               22.99 ( 36.99)     14.68 ( 23.61)     10.53 ( 16.94)     22.38 ( 36.01)

                                          H-TRAN COMPOSITE RESULTS
             HC    GRAMS/KM (GRAMS/MILE)      .75 ( 1.21)                    PARTICULATE RATE
             CO    GRAMS/KM (GRAMS/MILE)     7.46 ( 12.00)                   GRAMS/TEST       14.743
             CO2   GRAMS/KM (GRAMS/MILE)  1274.73 (2051.04)                  GRAMS/KG FUEL     3.99
             NOX   GRAMS/KM (GRAMS/MILE)    13.73 (22.09)                    GRAMS/KM          1.62
                                                                             GRAMS/MILE        2.60
             TOTAL DISTANCE  KM (MILES)     9.128 ( 5.67)
             FUEL CONSUMPTION  KG (LB)      3.694 ( 8.145)                   FILTER EFF.      91.79
             FUEL ECONOMY  L/100KM (MPG)   47.83 ( 4.92)
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TABLE D-3. H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 2162
DATE 11/29/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-597-F
ODOMETER 88619. KM(55065. MILES)

BAROMETER 739.39 MM HG(29.11 IN HG)
RELATIVE HUMIDITY 42. PCT

DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)
ABS. HUMIDITY 7.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR .94

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	255.28 (9013.9)	255.27 (9013.7)	255.34 (9016.0)	255.25 (9012.8)
TOT. 20X20 RATE SCMM (SCFM)	3.25 (114.7)	3.25 (114.7)	3.25 (114.7)	3.25 (114.7)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.03 (1.23)	.03 (1.23)	.03 (1.23)	.03 (1.23)
TOT FLOW STD. CU. METRES(SCF)	1094.6 (38649.)	1228.1 (43366.)	1150.9 (40637.)	1128.9 (39862.)
HC SAMPLE METER/RANGE/PPM	8.8/21/ 4.42	10.1/21/ 5.03	14.3/21/ 7.15	10.1/21/ 5.06
HC BCKGRD METER/RANGE/PPM	5.0/ 1/ 2.50	5.5/ 1/ 2.75	6.0/ 1/ 3.00	6.5/ 1/ 3.25
CO SAMPLE METER/RANGE/PPM	21.7/13/19.69	15.7/13/14.14	8.4/13/ 7.50	14.7/13/13.22
CO BCKGRD METER/RANGE/PPM	.6/13/ .53	.5/13/ .44	1.0/13/ .89	.9/13/ .80
CO2 SAMPLE METER/RANGE/PCT	59.6/13/.1195	70.7/13/.1445	75.2/12/.3187	56.8/13/.1133
CO2 BCKGRD METER/RANGE/PCT	20.1/13/.0368	19.9/13/.0364	11.3/12/.0382	19.7/13/.0360
NOX SAMPLE METER/RANGE/PPM	10.1/12/10.15	13.3/12/13.29	31.1/12/31.12	10.4/12/10.44
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ .14	.5/ 1/ .14	1.3/ 1/ .38	1.1/ 1/ .32
DILUTION FACTOR	109.98	91.54	41.85	116.39
HC CONCENTRATION PPM	1.94	2.31	4.22	1.83
CO CONCENTRATION PPM	18.85	13.48	6.50	12.24
CO2 CONCENTRATION PCT	.0830	.1085	.2814	.0776
NOX CONCENTRATION PPM	10.01	13.15	30.75	10.13
HC MASS GRAMS	1.227	1.634	2.799	1.194
CO MASS GRAMS	24.024	19.269	8.709	16.082
CO2 MASS GRAMS	1662.98	2438.90	5929.32	1604.01
NOX MASS GRAMS	19.705	29.048	63.654	20.562
MASS OF FUEL BURNED GRAMS	535.28	776.98	1868.97	512.81
MEASURED DISTANCE KM (MILES)	.866 (.538)	1.894 (1.177)	5.476 (3.403)	.891 (.554)
FUEL ECONOMY L/100KM (MPG)	73.03 (3.221)	48.48 (4.853)	40.34 (5.831)	68.02 (3.458)
HC GRAMS/KM (GRAMS/MILE)	1.42 (2.28)	.86 (1.39)	.51 (.82)	1.34 (2.16)
CO GRAMS/KM (GRAMS/MILE)	27.73 (44.62)	10.17 (16.37)	1.59 (2.56)	18.05 (29.04)
CO2 GRAMS/KM (GRAMS/MILE)	1919.6 (3088.6)	1287.5 (2071.5)	1082.8 (1742.2)	1800.1 (2896.3)
NOX GRAMS/KM (GRAMS/MILE)	22.75 (36.60)	15.33 (24.67)	11.62 (18.70)	23.08 (37.13)

H-TRAN COMPOSITE RESULTS

	HC GRAMS/KM (GRAMS/MILE)	.75 (1.21)
	CO GRAMS/KM (GRAMS/MILE)	7.46 (12.00)
	CO2 GRAMS/KM (GRAMS/MILE)	1274.73 (2051.04)
CONTINUOUS	NOX GRAMS/KM (GRAMS/MILE)	14.57 (23.44)

TOTAL DISTANCE KM (MILES)	9.128 (5.67)
FUEL CONSUMPTION KG (LB)	3.694 (8.145)
FUEL ECONOMY L/100KM (MPG)	47.83 (4.92)

PARTICULATE RATE

GRAMS/TEST	14.743
GRAMS/KG FUEL	3.99
GRAMS/KM	1.62
GRAMS/MILE	2.60

FILTER EFF. 91.79

L-4

TABLE D-4. H-TRAN VEHICLE EMISSIONS RESULTS

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                                   PROJECT 03-5428-001

TEST NO.   2       RUN   1          VEHICLE NO. 2162            TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04     DATE   11/30/84             ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6        BAG CART NO.  1             DIESEL     EM-597-F
TRANSMISSION A-3                    DYNO NO.      4             ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)            CVS NO.      11

BAROMETER 743.20 MM HG(29.26 IN HG) DRY BULB TEMP. 16.7 DEG C(62.0 DEG F)
RELATIVE HUMIDITY  46. PCT          ABS. HUMIDITY  5.5 GM/KG     NOX HUMIDITY CORRECTION FACTOR   .91
BAG RESULTS
  BAG NUMBER                              1                2                3                4
  DESCRIPTION                           NYNF             LANF              LAF             NYNF

  RUN TIME              SECONDS         254.0            285.0            267.0            262.0
  TOT. BLOWER RATE SCMM (SCFM)     256.36 ( 9052.2) 256.40 ( 9053.4) 256.45 ( 9055.3) 256.44 ( 9054.9)
  TOT. 20X20 RATE SCMM (SCFM)        3.26 (115.3)     3.26 (115.3)     3.26 (115.3)     3.26 (115.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)   .04 ( 1.27)      .04 ( 1.27)      .04 ( 1.27)      .04 ( 1.27)
  TOT FLOW STD. CU. METRES(SCF)    1099.2 ( 38814.) 1233.6 ( 43557.) 1155.9 ( 40814.) 1134.2 ( 40049.)

  HC  SAMPLE METER/RANGE/PPM         9.2/21/ 4.62    11.1/21/ 5.56    15.8/21/ 7.90    11.5/21/ 5.77
  HC  BCKGRD METER/RANGE/PPM         6.5/ 1/ 3.25     7.0/ 1/ 3.50     7.5/ 1/ 3.75     8.0/ 1/ 4.00
  CO  SAMPLE METER/RANGE/PPM        19.9/13/18.01    13.8/13/12.40     7.1/13/ 6.33    13.0/13/11.67
  CO  BCKGRD METER/RANGE/PPM         1.0/13/  .89     1.0/13/  .89     1.1/13/  .97      .9/13/  .80
  CO2 SAMPLE METER/RANGE/PCT        57.2/13/.1142    67.5/13/.1371    71.9/12/.3013    56.0/13/.1116
  CO2 BCKGRD METER/RANGE/PCT        20.4/13/.0374    20.9/13/.0384    11.4/12/.0386    20.4/13/.0374
  NOX SAMPLE METER/RANGE/PPM        35.7/ 1/10.61    43.3/ 1/12.87    98.5/ 1/29.30    36.4/ 1/10.82
  NOX BCKGRD METER/RANGE/PPM         1.8/ 1/  .53     2.1/ 1/  .62     2.1/ 1/  .62     2.2/ 1/  .65
  DILUTION FACTOR                   115.09            96.47            44.27           118.27

  HC  CONCENTRATION PPM              1.40             2.09             4.24             1.80
  CO  CONCENTRATION PPM             16.84            11.32             5.26            10.70
  CO2 CONCENTRATION PCT              .0771            .0991            .2636            .0745
  NOX CONCENTRATION PPM             10.09            12.26            28.69            10.18
  HC  MASS GRAMS                      .887            1.490            2.823            1.180
  CO  MASS GRAMS                    21.554           16.260            7.081           14.122
  CO2 MASS GRAMS                  1552.09          2239.19          5577.67          1546.91
  NOX MASS GRAMS                    19.380           26.434           57.953           20.175
  MASS OF FUEL BURNED GRAMS        498.89           712.64          1757.77           493.90
  MEASURED DISTANCE  KM (MILES)     .829 ( .515)    1.826 (1.135)    5.387 (3.348)     .848 ( .527)
  FUEL ECONOMY  L/100KM (MPG)      71.11 ( 3.308)   46.12 ( 5.100)   38.57 ( 6.100)   68.80 ( 3.419)

  HC   GRAMS/KM (GRAMS/MILE)        1.07 (  1.72)     .82 (  1.31)     .52 (   .84)    1.39 (  2.24)
  CO   GRAMS/KM (GRAMS/MILE)       25.99 ( 41.83)    8.90 ( 14.33)    1.31 (  2.11)   16.65 ( 26.78)
  CO2  GRAMS/KM (GRAMS/MILE)      1871.9 (3011.9)  1226.1 (1972.9)  1035.4 (1665.9)  1823.3 (2933.7)
  NOX  GRAMS/KM (GRAMS/MILE)       23.37 ( 37.61)   14.47 ( 23.29)   10.76 ( 17.31)   23.78 ( 38.26)

                              H-TRAN COMPOSITE RESULTS
         HC   GRAMS/KM (GRAMS/MILE)     .72 ( 1.15)             PARTICULATE RATE
         CO   GRAMS/KM (GRAMS/MILE)    6.64 ( 10.68)            GRAMS/TEST       13.277
         CO2  GRAMS/KM (GRAMS/MILE) 1227.76 (1975.46)           GRAMS/KG FUEL     3.83
         NOX  GRAMS/KM (GRAMS/MILE)   13.94 (22.43)             GRAMS/KM          1.49
                                                                GRAMS/MILE        2.40

         TOTAL DISTANCE  KM (MILES)    8.891 ( 5.53)
         FUEL CONSUMPTION  KG (LB)     3.463 ( 7.636)           FILTER EFF.      96.40
         FUEL ECONOMY  L/100KM (MPG)  46.04 ( 5.11)
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TABLE D-4. H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 2 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 2162
DATE 11/30/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-597-F
ODOMETER 88619. KM(55065. MILES)

BAROMETER 743.20 MM HG(29.26 IN HG)
RELATIVE HUMIDITY 46. PCT

DRY BULB TEMP. 16.7 DEG C(62.0 DEG F)
ABS. HUMIDITY 5.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .91

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	256.36 (9052.2)	256.40 (9053.4)	256.45 (9055.3)	256.44 (9054.9)
TOT. 20X20 RATE SCMM (SCFM)	3.26 (115.3)	3.26 (115.3)	3.26 (115.3)	3.26 (115.3)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.27)	.04 (1.27)	.04 (1.27)	.04 (1.27)
TOT FLOW STD. CU. METRES(SCF)	1099.2 (38814.)	1233.6 (43557.)	1155.9 (40814.)	1134.2 (40049.)
HC SAMPLE METER/RANGE/PPM	9.2/21/ 4.62	11.1/21/ 5.56	15.8/21/ 7.90	11.5/21/ 5.77
HC BCKGRD METER/RANGE/PPM	6.5/ 1/ 3.25	7.0/ 1/ 3.50	7.5/ 1/ 3.75	8.0/ 1/ 4.00
CO SAMPLE METER/RANGE/PPM	19.9/13/18.01	13.8/13/12.40	7.1/13/ 6.33	13.0/13/11.67
CO BCKGRD METER/RANGE/PPM	1.0/13/ .89	1.0/13/ .89	1.1/13/ .97	.9/13/ .80
CO2 SAMPLE METER/RANGE/PCT	57.2/13/.1142	67.5/13/.1371	71.9/12/.3013	56.0/13/.1116
CO2 BCKGRD METER/RANGE/PCT	20.4/13/.0374	20.9/13/.0384	11.4/12/.0386	20.4/13/.0374
NOX SAMPLE METER/RANGE/PPM	10.8/12/10.77	13.9/12/13.89	32.0/12/31.98	11.2/12/11.21
NOX BCKGRD METER/RANGE/PPM	1.8/ 1/ .53	2.1/ 1/ .62	2.1/ 1/ .62	2.2/ 1/ .65
DILUTION FACTOR	115.09	96.47	44.27	118.27
HC CONCENTRATION PPM	1.40	2.09	4.24	1.80
CO CONCENTRATION PPM	16.84	11.32	5.26	10.70
CO2 CONCENTRATION PCT	.0771	.0991	.2636	.0745
NOX CONCENTRATION PPM	10.25	13.28	31.38	10.57
HC MASS GRAMS	.887	1.490	2.823	1.180
CO MASS GRAMS	21.554	16.260	7.081	14.122
CO2 MASS GRAMS	1552.09	2239.19	5577.67	1546.91
NOX MASS GRAMS	19.686	28.635	63.380	20.951
MASS OF FUEL BURNED GRAMS	498.89	712.64	1757.77	493.90
MEASURED DISTANCE KM (MILES)	.829 (.515)	1.826 (1.135)	5.387 (3.348)	.848 (.527)
FUEL ECONOMY L/100KM (MPG)	71.11 (3.308)	46.12 (5.100)	38.57 (6.100)	68.80 (3.419)
HC GRAMS/KM (GRAMS/MILE)	1.07 (1.72)	.82 (1.31)	.52 (.84)	1.39 (2.24)
CO GRAMS/KM (GRAMS/MILE)	25.99 (41.83)	8.90 (14.33)	1.31 (2.11)	16.65 (26.78)
CO2 GRAMS/KM (GRAMS/MILE)	1871.9 (3011.9)	1226.1 (1972.9)	1035.4 (1665.9)	1823.3 (2933.7)
NOX GRAMS/KM (GRAMS/MILE)	23.74 (38.20)	15.68 (25.23)	11.77 (18.93)	24.69 (39.73)

H-TRAN COMPOSITE RESULTS

	HC GRAMS/KM (GRAMS/MILE)	.72 (1.15)
	CO GRAMS/KM (GRAMS/MILE)	6.64 (10.68)
	CO2 GRAMS/KM (GRAMS/MILE)	1227.76 (1975.46)
CONTINUOUS	NOX GRAMS/KM (GRAMS/MILE)	14.92 (24.01)
	TOTAL DISTANCE KM (MILES)	8.891 (5.53)
	FUEL CONSUMPTION KG (LB)	3.463 (7.636)
	FUEL ECONOMY L/100KM (MPG)	46.04 (5.11)

PARTICULATE RATE	
GRAMS/TEST	13.277
GRAMS/KG FUEL	3.83
GRAMS/KM	1.49
GRAMS/MILE	2.40

FILTER EFF. 96.40

TABLE D-5. BUS F VEHICLE EMISSIONS RESULTS

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                                          PROJECT 03-5428-001

TEST NO.   1        RUN   1                 VEHICLE NO. 2162                TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04             DATE    11/29/84                ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE   9.0 L( 552. CID) V-6               BAG CART NO.  1                 DIESEL     EM-597-F
TRANSMISSION A-3                            DYNO NO.      4                 ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                    CVS NO.      11

BAROMETER 738.89 MM HG(29.09 IN HG)         DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
RELATIVE HUMIDITY  37. PCT                  ABS. HUMIDITY  6.8 GM/KG        NOX HUMIDITY CORRECTION FACTOR   .93

BAG RESULTS
  TEST CYCLE                                  BUS F

  RUN TIME                  SECONDS            1193.1
  TOT. BLOWER RATE SCMM (SCFM)              171.39 ( 6051.7)
  TOT. 20X20 RATE SCMM (SCFM)                 3.26 (115.1)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .04 ( 1.24)
  TOT FLOW STD. CU. METRES(SCF)             3473.5 (122651.)

  HC  SAMPLE METER/RANGE/PPM                  6.8/22/ 6.83
  HC  BCKGRD METER/RANGE/PPM                  3.6/ 2/ 3.60
  CO  SAMPLE METER/RANGE/PPM                  4.8/13/ 4.27
  CO  BCKGRD METER/RANGE/PPM                   .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT                 68.1/13/.1385
  CO2 BCKGRD METER/RANGE/PCT                 19.2/13/.0350
  NOX SAMPLE METER/RANGE/PPM                 45.9/ 1/13.65
  NOX BCKGRD METER/RANGE/PPM                   .5/ 1/  .14
  DILUTION FACTOR                               95.98

  HC  CONCENTRATION PPM                          3.27
  CO  CONCENTRATION PPM                          3.77
  CO2 CONCENTRATION PCT                         .1038
  NOX CONCENTRATION PPM                         13.51
  HC  MASS GRAMS                                6.547
  CO  MASS GRAMS                               15.260
  CO2 MASS GRAMS                              6602.36
  NOX MASS GRAMS                               83.727
  MASS OF FUEL BURNED GRAMS                   2087.29
  MEASURED DISTANCE  KM (MILES)             4.775 (2.967)
  FUEL ECONOMY  L/100KM (MPG)               51.67 ( 4.553)

  HC    GRAMS/KM (GRAMS/MILE)                1.37 (  2.21)
  CO    GRAMS/KM (GRAMS/MILE)                3.20 (  5.14)
  CO2   GRAMS/KM (GRAMS/MILE)              1382.8 (2224.9)
  NOX   GRAMS/KM (GRAMS/MILE)               17.54 ( 28.21)

                                              BUS F  COMPOSITE RESULTS
                HC    GRAMS/KM (GRAMS/MILE)    1.37 ( 2.21)                   PARTICULATE RATE
                CO    GRAMS/KM (GRAMS/MILE)    3.20 (  5.14)                  GRAMS/TEST        5.625
                CO2   GRAMS/KM (GRAMS/MILE) 1382.78 (2224.89)                 GRAMS/KG FUEL     2.70
                NOX   GRAMS/KM (GRAMS/MILE)   17.54 (28.21)                   GRAMS/KM          1.18
                                                                              GRAMS/MILE        1.90

                TOTAL DISTANCE  KM (MILES)     4.775 ( 2.97)
                FUEL CONSUMPTION  KG (LB)      2.087 ( 4.602)                 FILTER EFF.     78.82
                FUEL ECONOMY  L/100KM (MPG)    51.67 ( 4.55)
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TABLE D-5. BUS F VEHICLE EMISSIONS RESULTS (Cont'd)

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                                      PROJECT 03-5428-001

TEST NO.   1        RUN   1                VEHICLE NO. 2162             TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE   11/29/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1              DIESEL     EM-597-F
TRANSMISSION A-3                           DYNO NO.      4              ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 738.89 MM HG(29.09 IN HG)        DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
RELATIVE HUMIDITY  37. PCT                 ABS. HUMIDITY  6.8 GM/KG     NOX HUMIDITY CORRECTION FACTOR   .93

BAG RESULTS
  TEST CYCLE                                 BUS F

  RUN TIME                 SECONDS           1193.1
  TOT. BLOWER RATE SCMM (SCFM)             171.39 ( 6051.7)
  TOT. 20X20 RATE SCMM (SCFM)                3.26 (115.1)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)           .04 ( 1.24)
  TOT FLOW STD. CU. METRES(SCF)            3473.5 (122651.)

  HC  SAMPLE METER/RANGE/PPM                6.8/22/ 6.83
  HC  BCKGRD METER/RANGE/PPM                3.6/ 2/ 3.60
  CO  SAMPLE METER/RANGE/PPM                4.8/13/ 4.27
  CO  BCKGRD METER/RANGE/PPM                 .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT               68.1/13/.1385
  CO2 BCKGRD METER/RANGE/PCT               19.2/13/.0350
  NOX SAMPLE METER/RANGE/PPM               15.2/12/15.17
  NOX BCKGRD METER/RANGE/PPM                 .5/ 1/  .14
  DILUTION FACTOR                             95.98

  HC  CONCENTRATION PPM                        3.27
  CO  CONCENTRATION PPM                        3.77
  CO2 CONCENTRATION PCT                        .1038
  NOX CONCENTRATION PPM                       15.03
  HC  MASS GRAMS                               6.547
  CO  MASS GRAMS                              15.260
  CO2 MASS GRAMS                            6602.36
  NOX MASS GRAMS                              93.174
  MASS OF FUEL BURNED GRAMS                 2087.29
  MEASURED DISTANCE  KM (MILES)             4.775 (2.967)
  FUEL ECONOMY  L/100KM (MPG)              51.67 ( 4.553)

  HC   GRAMS/KM (GRAMS/MILE)                1.37 (   2.21)
  CO   GRAMS/KM (GRAMS/MILE)                3.20 (   5.14)
  CO2  GRAMS/KM (GRAMS/MILE)              1382.8 (2224.9)
  NOX  GRAMS/KM (GRAMS/MILE)               19.51 ( 31.40)

                                         BUS F  COMPOSITE RESULTS
              HC   GRAMS/KM (GRAMS/MILE)    1.37 ( 2.21)                PARTICULATE RATE
              CO   GRAMS/KM (GRAMS/MILE)    3.20 (   5.14)              GRAMS/TEST       5.625
              CO2  GRAMS/KM (GRAMS/MILE) 1382.78 (2224.89)              GRAMS/KG FUEL    2.70
   CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)   19.51 (31.40)                GRAMS/KM         1.18
                                                                        GRAMS/MILE       1.90


              TOTAL DISTANCE  KM (MILES)     4.775 ( 2.97)
              FUEL CONSUMPTION  KG (LB)      2.087 ( 4.602)             FILTER EFF.     78.82
              FUEL ECONOMY  L/100KM (MPG)    51.67 ( 4.55)
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TABLE D-6. BUS F VEHICLE EMISSIONS RESULTS

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                                   PROJECT 03-5428-001

TEST NO.   2       RUN   1                 VEHICLE NO. 2162                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE    11/30/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1                   DIESEL    EM-597-F
TRANSMISSION A-3                           DYNO NO.      4                   ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 742.95 MM HG(29.25 IN HG)        DRY BULB TEMP. 20.0 DEG C(68.0 DEG F)
RELATIVE HUMIDITY  31. PCT                 ABS. HUMIDITY  4.7 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .90

BAG RESULTS
  TEST CYCLE                                 BUS F

  RUN TIME                SECONDS            1197.4
  TOT. BLOWER RATE SCMM (SCFM)            171.30 ( 6048.6)
  TOT. 20X20 RATE SCMM (SCFM)               3.26 (115.0)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)          .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)           3484.3 (123030.)

  HC  SAMPLE METER/RANGE/PPM               14.6/21/ 7.29
  HC  BCKGRD METER/RANGE/PPM                7.3/ 1/ 3.65
  CO  SAMPLE METER/RANGE/PPM                4.6/13/ 4.09
  CO  BCKGRD METER/RANGE/PPM                 .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT               67.7/13/.1376
  CO2 BCKGRD METER/RANGE/PCT               20.3/13/.0372
  NOX SAMPLE METER/RANGE/PPM               49.2/ 1/14.63
  NOX BCKGRD METER/RANGE/PPM                1.7/ 1/  .50
  DILUTION FACTOR                             96.60

  HC  CONCENTRATION PPM                        3.68
  CO  CONCENTRATION PPM                        3.60
  CO2 CONCENTRATION PCT                        .1008
  NOX CONCENTRATION PPM                       14.14
  HC  MASS GRAMS                               7.385
  CO  MASS GRAMS                              14.619
  CO2 MASS GRAMS                            6428.27
  NOX MASS GRAMS                              84.848
  MASS OF FUEL BURNED GRAMS                 2033.14
  MEASURED DISTANCE  KM (MILES)           4.768 (2.963)
  FUEL ECONOMY  L/100KM (MPG)             50.40 ( 4.667)

  HC   GRAMS/KM (GRAMS/MILE)               1.55 (  2.49)
  CO   GRAMS/KM (GRAMS/MILE)               3.07 (  4.93)
  CO2  GRAMS/KM (GRAMS/MILE)             1348.3 (2169.4)
  NOX  GRAMS/KM (GRAMS/MILE)              17.80 ( 28.63)

                                          BUS F  COMPOSITE RESULTS
              HC   GRAMS/KM (GRAMS/MILE)     1.55 ( 2.49)                 PARTICULATE RATE
              CO   GRAMS/KM (GRAMS/MILE)     3.07 (  4.93)                GRAMS/TEST        4.225
              CO2  GRAMS/KM (GRAMS/MILE)  1348.26 (2169.35)               GRAMS/KG FUEL     2.08
              NOX  GRAMS/KM (GRAMS/MILE)    17.80 (28.63)                 GRAMS/KM           .89
                                                                          GRAMS/MILE        1.43

              TOTAL DISTANCE  KM (MILES)     4.768 ( 2.96)
              FUEL CONSUMPTION  KG (LB)      2.033 ( 4.483)               FILTER EFF.      90.58
              FUEL ECONOMY  L/100KM (MPG)    50.40 ( 4.67)
```

D-6 cont

TABLE D-6.BUS F VEHICLE EMISSIONS RESULTS (Cont'd)

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                                                   PROJECT 03-5428-001
                                                                                   TEST WEIGHT 13608. KG(30000. LBS)
                                               VEHICLE NO  2162                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
TEST NO.   2          RUN   1                  DATE    11/30/84                    DIESEL      EM-597-F
VEHICLE MODEL 1983 GMC RTSII 04                BAG CART NO.  1                     ODOMETER  88619. KM( 55065. MILES)
ENGINE  9.0 L( 552. CID) V-6                   DYNO NO.      4
TRANSMISSION A-3                               CVS NO.       11
GVW16738. KG(36900. LBS)
                                               DRY BULB TEMP. 20.0 DEG C(68.0 DEG F)
BAROMETER 742.95 MM HG(29.25 IN HG)            ABS. HUMIDITY  4.7 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .90
RELATIVE HUMIDITY  31. PCT

BAG RESULTS                                       BUS F
   TEST CYCLE
                                                  1197.4
   RUN TIME                SECONDS            171.30 ( 6048.6)
   TOT. BLOWER RATE SCMM (SCFM)                 3.26 (115.0)
   TOT. 20X20 RATE SCMM (SCFM)                   .04 ( 1.28)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)          3484.3 (123030.)
   TOT FLOW STD. CU. METRES(SCF)

   HC  SAMPLE METER/RANGE/PPM                   14.6/21/ 7.29
   HC  BCKGRD METER/RANGE/PPM                    7.3/ 1/ 3.65
   CO  SAMPLE METER/RANGE/PPM                    4.6/13/ 4.09
   CO  BCKGRD METER/RANGE/PPM                     .5/13/  .44
   CO2 SAMPLE METER/RANGE/PCT                   67.7/13/.1376
   CO2 BCKGRD METER/RANGE/PCT                   20.3/13/.0372
   NOX SAMPLE METER/RANGE/PPM                   15.1/12/15.12
   NOX BCKGRD METER/RANGE/PPM                    1.7/ 1/  .50
   DILUTION FACTOR                                96.60

   HC  CONCENTRATION PPM                           3.68
   CO  CONCENTRATION PPM                           3.60
   CO2 CONCENTRATION PCT                           .1008
   NOX CONCENTRATION PPM                          14.62
   HC  MASS GRAMS                                  7.385
   CO  MASS GRAMS                                 14.619
   CO2 MASS GRAMS                               6428.27
   NOX MASS GRAMS                                 87.777
   MASS OF FUEL BURNED GRAMS                    2033.14
   MEASURED DISTANCE  KM (MILES)                4.768 (2.963)
   FUEL ECONOMY  L/100KM (MPG)                  50.40 ( 4.667)

   HC   GRAMS/KM (GRAMS/MILE)                    1.55 (   2.49)
   CO   GRAMS/KM (GRAMS/MILE)                    3.07 (   4.93)
   CO2  GRAMS/KM (GRAMS/MILE)                  1348.3 (2169.4)
   NOX  GRAMS/KM (GRAMS/MILE)                   18.41 ( 29.62)

                                              BUS F  COMPOSITE RESULTS              PARTICULATE RATE
                     HC   GRAMS/KM (GRAMS/MILE)    1.55 ( 2.49)                     GRAMS/TEST        4.225
                     CO   GRAMS/KM (GRAMS/MILE)    3.07 (  4.93)                    GRAMS/KG FUEL     2.08
                     CO2  GRAMS/KM (GRAMS/MILE) 1348.26 (2169.35)                   GRAMS/KM           .89
          CONTINUOUSNOX   GRAMS/KM (GRAMS/MILE)   18.41 (29.62)                     GRAMS/MILE        1.43


                TOTAL DISTANCE  KM (MILES)       4.768 ( 2.96)                      FILTER EFF.     90.58
                FUEL CONSUMPTION  KG (LB)        2.033 ( 4.483)
                FUEL ECONOMY  L/100KM (MPG)      50.40 ( 4.67)
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                              TABLE D-7.  BUS UN VEHICLE EMISSIONS RESULTS
                                               PROJECT 03-5428-001
TEST NO.   1          RUN   1
VEHICLE MODEL 1983 GMC RTSII 04              VEHICLE NO. 2162
ENGINE  9.0 L( 552. CID) V-6                 DATE    11/29/84                  TEST WEIGHT 13608. KG(30000. LBS)
TRANSMISSION A-3                             BAG CART NO.  1                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
GVW16738. KG(36900. LBS)                     DYNO NO.       4                  DIESEL     EM-597-F
                                             CVS NO.       11                  ODOMETER  88619. KM( 55065. MILES)

BAROMETER 737.87 MM HG(29.05 IN HG)
RELATIVE HUMIDITY  41. PCT                   DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
                                             ABS. HUMIDITY  7.8 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .95
BAG RESULTS
   TEST CYCLE
                                                     BUS UN
   RUN TIME                   SECONDS
   TOT. BLOWER RATE SCMM (SCFM)                      1198.4
   TOT. 20X20 RATE SCMM (SCFM)                   170.28 ( 6012.7)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)               3.21 (113.5)
   TOT FLOW STD. CU. METRES(SCF)                    .03 (  .90)
                                                3465.8 (122378.)
   HC   SAMPLE METER/RANGE/PPM
   HC   BCKGRD METER/RANGE/PPM                    13.7/21/ 6.86
   CO   SAMPLE METER/RANGE/PPM                     7.5/ 1/ 3.75
   CO   BCKGRD METER/RANGE/PPM                    34.4/13/31.70
   CO2  SAMPLE METER/RANGE/PCT                      .5/13/  .44
   CO2  BCKGRD METER/RANGE/PCT                    77.9/13/.1616
   NOX  SAMPLE METER/RANGE/PPM                    19.6/13/.0358
   NOX  BCKGRD METER/RANGE/PPM                    50.1/ 1/14.90
   DILUTION FACTOR                                  .4/ 1/  .11
                                                    81.01
   HC   CONCENTRATION PPM
   CO   CONCENTRATION PPM                            3.15
   CO2  CONCENTRATION PCT                           30.75
   NOX  CONCENTRATION PPM                           .1262
   HC   MASS GRAMS                                  14.79
   CO   MASS GRAMS                                   6.298
   CO2  MASS GRAMS                                 124.073
   NOX  MASS GRAMS                                8009.20
   MASS OF FUEL BURNED GRAMS                        93.093
   MEASURED DISTANCE  KM (MILES)                  2582.50
   FUEL ECONOMY  L/100KM (MPG)                   4.815 (2.993)
                                                 63.39 ( 3.711)
   HC    GRAMS/KM (GRAMS/MILE)
   CO    GRAMS/KM (GRAMS/MILE)                    1.31 (  2.10)
   CO2   GRAMS/KM (GRAMS/MILE)                   25.77 ( 41.46)
   NOX   GRAMS/KM (GRAMS/MILE)                  1663.3 (2676.2)
                                                 19.33 ( 31.11)

                                                 BUS UN COMPOSITE RESULTS
               HC    GRAMS/KM (GRAMS/MILE)        1.31 ( 2.10)
               CO    GRAMS/KM (GRAMS/MILE)       25.77 ( 41.46)          PARTICULATE RATE
               CO2   GRAMS/KM (GRAMS/MILE)     1663.28 (2676.22)         GRAMS/TEST        17.899
               NOX   GRAMS/KM (GRAMS/MILE)       19.33 (31.11)           GRAMS/KG FUEL      6.93
                                                                         GRAMS/KM           3.72
                                                                         GRAMS/MILE         5.98

               TOTAL DISTANCE  KM (MILES)       4.815 ( 2.99)
               FUEL CONSUMPTION  KG (LB)        2.582 ( 5.694)
               FUEL ECONOMY  L/100KM (MPG)      63.39 ( 3.71)            FILTER EFF.    100.00
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TABLE D-7. BUS UN VEHICLE EMISSIONS RESULTS (Cont'd)

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                                          PROJECT 03-5428-001

TEST NO.  1        RUN   1                    VEHICLE NO. 2162               TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04               DATE    11/29/84               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                  BAG CART NO.  1                DIESEL     EM-597-F
TRANSMISSION A-3                              DYNO NO.      4                ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                      CVS NO.      11

BAROMETER 737.87 MM HG(29.05 IN HG)           DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
RELATIVE HUMIDITY  41. PCT                    ABS. HUMIDITY  7.8 GM/KG       NOX HUMIDITY CORRECTION FACTOR   .95

BAG RESULTS
  TEST CYCLE                                      BUS UN

  RUN TIME                 SECONDS                1198.4
  TOT. BLOWER RATE SCMM (SCFM)                170.28 ( 6012.7)
  TOT. 20X20 RATE SCMM (SCFM)                   3.21 (113.5)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (   .90)
  TOT FLOW STD. CU. METRES(SCF)               3465.8 (122378.)

  HC  SAMPLE METER/RANGE/PPM                  13.7/21/ 6.86
  HC  BCKGRD METER/RANGE/PPM                   7.5/ 1/ 3.75
  CO  SAMPLE METER/RANGE/PPM                  34.4/13/31.70
  CO  BCKGRD METER/RANGE/PPM                    .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT                  77.9/13/.1616
  CO2 BCKGRD METER/RANGE/PCT                  19.6/13/.0358
  NOX SAMPLE METER/RANGE/PPM                  15.7/12/15.74
  NOX BCKGRD METER/RANGE/PPM                    .4/ 1/  .11
  DILUTION FACTOR                                 81.01

  HC  CONCENTRATION PPM                            3.15
  CO  CONCENTRATION PPM                           30.75
  CO2 CONCENTRATION PCT                           .1262
  NOX CONCENTRATION PPM                           15.63
  HC  MASS GRAMS                                  6.298
  CO  MASS GRAMS                                124.073
  CO2 MASS GRAMS                                8009.20
  NOX MASS GRAMS                                 98.410
  MASS OF FUEL BURNED GRAMS                     2582.50
  MEASURED DISTANCE  KM (MILES)              4.815 (2.993)
  FUEL ECONOMY  L/100KM (MPG)                63.39 ( 3.711)

  HC   GRAMS/KM (GRAMS/MILE)                  1.31 (  2.10)
  CO   GRAMS/KM (GRAMS/MILE)                 25.77 ( 41.46)
  CO2  GRAMS/KM (GRAMS/MILE)                1663.3 (2676.2)
  NOX  GRAMS/KM (GRAMS/MILE)                 20.44 ( 32.88)

                                              BUS UN COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)     1.31 ( 2.10)                PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)    25.77 ( 41.46)               GRAMS/TEST       17.899
                CO2  GRAMS/KM (GRAMS/MILE)  1663.28 (2676.22)              GRAMS/KG FUEL     6.93
     CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)    20.44 (32.88)                GRAMS/KM          3.72
                                                                           GRAMS/MILE        5.98

                TOTAL DISTANCE  KM (MILES)     4.815 ( 2.99)
                FUEL CONSUMPTION  KG (LB)      2.582 ( 5.694)              FILTER EFF.    100.00
                FUEL ECONOMY  L/100KM (MPG)    63.39 ( 3.71)
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TABLE D-8. BUS UN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

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TEST NO.   2        RUN   1                      VEHICLE NO. 2162                      TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                  DATE    11/30/84                      ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                     BAG CART NO.  1                       DIESEL     EM-597-F
TRANSMISSION A-3                                 DYNO NO.      4                       ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                         CVS NO.      11

BAROMETER 742.44 MM HG(29.23 IN HG)              DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  23. PCT                       ABS. HUMIDITY  3.7 GM/KG              NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
  TEST CYCLE                                       BUS UN

  RUN TIME                  SECONDS                1197.0
  TOT. BLOWER RATE SCMM (SCFM)                  173.00 ( 6108.5)
  TOT. 20X20 RATE SCMM (SCFM)                     3.25 (114.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                .03 (  .94)
  TOT FLOW STD. CU. METRES(SCF)                 3516.7 (124174.)

  HC  SAMPLE METER/RANGE/PPM                     12.7/21/ 6.37
  HC  BCKGRD METER/RANGE/PPM                      6.8/ 1/ 3.40
  CO  SAMPLE METER/RANGE/PPM                     28.5/13/26.07
  CO  BCKGRD METER/RANGE/PPM                       .3/13/  .27
  CO2 SAMPLE METER/RANGE/PCT                     75.2/13/.1551
  CO2 BCKGRD METER/RANGE/PCT                     19.8/13/.0362
  NOX SAMPLE METER/RANGE/PPM                     50.9/ 1/15.13
  NOX BCKGRD METER/RANGE/PPM                       .6/ 1/  .17
  DILUTION FACTOR                                  84.65

  HC  CONCENTRATION PPM                             3.01
  CO  CONCENTRATION PPM                            25.54
  CO2 CONCENTRATION PCT                            .1193
  NOX CONCENTRATION PPM                            14.97
  HC  MASS GRAMS                                    6.104
  CO  MASS GRAMS                                  104.554
  CO2 MASS GRAMS                                  7680.29
  NOX MASS GRAMS                                   89.203
  MASS OF FUEL BURNED GRAMS                       2469.39
  MEASURED DISTANCE  KM (MILES)                  4.764 (2.961)
  FUEL ECONOMY  L/100KM (MPG)                    61.27 ( 3.840)

  HC   GRAMS/KM (GRAMS/MILE)                      1.28 (  2.06)
  CO   GRAMS/KM (GRAMS/MILE)                     21.95 ( 35.31)
  CO2  GRAMS/KM (GRAMS/MILE)                    1612.3 (2594.1)
  NOX  GRAMS/KM (GRAMS/MILE)                     18.73 ( 30.13)

                                                   BUS UN COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)        1.28 ( 2.06)                   PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)       21.95 ( 35.31)                  GRAMS/TEST       15.052
                CO2  GRAMS/KM (GRAMS/MILE)     1612.25 (2594.12)                 GRAMS/KG FUEL     6.10
                NOX  GRAMS/KM (GRAMS/MILE)       18.73 (30.13)                   GRAMS/KM          3.16
                                                                                 GRAMS/MILE        5.08


                TOTAL DISTANCE  KM (MILES)       4.764 ( 2.96)
                FUEL CONSUMPTION  KG (LB)        2.469 ( 5.445)                  FILTER EFF.      98.22
                FUEL ECONOMY  L/100KM (MPG)      61.27 ( 3.84)
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TABLE D-8. BUS UN VEHICLE EMISSIONS RESULTS (Cont'd)

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                                        PROJECT 03-5428-001

TEST NO.   2        RUN   1              VEHICLE NO. 2162                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04          DATE    11/30/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6             BAG CART NO.  1                  DIESEL     EM-597-F
TRANSMISSION A-3                         DYNO NO.      4                  ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                 CVS NO.      11

BAROMETER 742.44 MM HG(29.23 IN HG)      DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  23. PCT               ABS. HUMIDITY  3.7 GM/KG         NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
  TEST CYCLE                                BUS UN

  RUN TIME                 SECONDS          1197.0
  TOT. BLOWER RATE SCMM (SCFM)           173.00 ( 6108.5)
  TOT. 20X20 RATE SCMM (SCFM)              3.25 (114.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)         .03 (  .94)
  TOT FLOW STD. CU. METRES(SCF)          3516.7 (124174.)

  HC  SAMPLE METER/RANGE/PPM               12.7/21/ 6.37
  HC  BCKGRD METER/RANGE/PPM                6.8/ 1/ 3.40
  CO  SAMPLE METER/RANGE/PPM               28.5/13/26.07
  CO  BCKGRD METER/RANGE/PPM                .3/13/  .27
  CO2 SAMPLE METER/RANGE/PCT               75.2/13/.1551
  CO2 BCKGRD METER/RANGE/PCT               19.8/13/.0362
  NOX SAMPLE METER/RANGE/PPM               15.8/12/15.83
  NOX BCKGRD METER/RANGE/PPM                .6/ 1/  .17
  DILUTION FACTOR                             84.65

  HC  CONCENTRATION PPM                        3.01
  CO  CONCENTRATION PPM                       25.54
  CO2 CONCENTRATION PCT                       .1193
  NOX CONCENTRATION PPM                       15.66
  HC  MASS GRAMS                               6.104
  CO  MASS GRAMS                             104.554
  CO2 MASS GRAMS                            7680.29
  NOX MASS GRAMS                              93.358
  MASS OF FUEL BURNED GRAMS                 2469.39
  MEASURED DISTANCE  KM (MILES)           4.764 (2.961)
  FUEL ECONOMY  L/100KM (MPG)             61.27 ( 3.840)

  HC   GRAMS/KM (GRAMS/MILE)               1.28 (  2.06)
  CO   GRAMS/KM (GRAMS/MILE)              21.95 ( 35.31)
  CO2  GRAMS/KM (GRAMS/MILE)             1612.3 (2594.1)
  NOX  GRAMS/KM (GRAMS/MILE)              19.60 ( 31.53)

                                             BUS UN COMPOSITE RESULTS
                 HC   GRAMS/KM (GRAMS/MILE)     1.28 ( 2.06)             PARTICULATE RATE
                 CO   GRAMS/KM (GRAMS/MILE)    21.95 ( 35.31)            GRAMS/TEST      15.052
                 CO2  GRAMS/KM (GRAMS/MILE)  1612.25 (2594.12)           GRAMS/KG FUEL    6.10
     CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)    19.60 (31.53)             GRAMS/KM         3.16
                                                                         GRAMS/MILE       5.08

                 TOTAL DISTANCE  KM (MILES)     4.764 ( 2.96)
                 FUEL CONSUMPTION  KG (LB)      2.469 ( 5.445)           FILTER EFF.     98.22
                 FUEL ECONOMY  L/100KM (MPG)    61.27 ( 3.84)
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TABLE D-9. IDLE VEHICLE EMISSIONS RESULTS

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                                                      PROJECT 03-5428-001

TEST NO.   1        RUN   1                      VEHICLE NO. 2162                    TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                  DATE    11/29/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                     BAG CART NO.  1                     DIESEL    EM-597-F
TRANSMISSION A-3                                 DYNO NO.      4                     ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                         CVS NO.      11

BAROMETER 737.62 MM HG(29.04 IN HG)              DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
RELATIVE HUMIDITY  41. PCT                       ABS. HUMIDITY  7.8 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .95

BAG RESULTS
   TEST CYCLE                                     IDLE

   RUN TIME                  SECONDS              900.0
   TOT. BLOWER RATE SCMM (SCFM)                86.05 ( 3038.4)
   TOT. 20X20 RATE SCMM (SCFM)                  3.23 (114.1)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 ( 1.00)
   TOT FLOW STD. CU. METRES(SCF)              1339.6 ( 47303.)

   HC  SAMPLE METER/RANGE/PPM                  18.4/21/ 9.18
   HC  BCKGRD METER/RANGE/PPM                   6.5/ 1/ 3.25
   CO  SAMPLE METER/RANGE/PPM                   4.6/13/ 4.09
   CO  BCKGRD METER/RANGE/PPM                    .8/13/  .71
   CO2 SAMPLE METER/RANGE/PCT                  77.2/13/.1599
   CO2 BCKGRD METER/RANGE/PCT                  24.1/13/.0447
   NOX SAMPLE METER/RANGE/PPM                  68.4/ 1/20.34
   NOX BCKGRD METER/RANGE/PPM                   2.5/ 1/  .74
   DILUTION FACTOR                                83.11

   HC  CONCENTRATION PPM                           5.97
   CO  CONCENTRATION PPM                           3.33
   CO2 CONCENTRATION PCT                           .1157
   NOX CONCENTRATION PPM                          19.61
   HC  MASS GRAMS                                  4.608
   CO  MASS GRAMS                                  5.197
   CO2 MASS GRAMS                               2837.77
   NOX MASS GRAMS                                 47.733
   MASS OF FUEL BURNED GRAMS                     898.26
   MEASURED DISTANCE  KM (MILES)                .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)                ****** (  .002)

   HC   GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO   GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO2  GRAMS/KM (GRAMS/MILE)                 ****** (******)
   NOX  GRAMS/KM (GRAMS/MILE)                  ***** (******)

                                            IDLE   COMPOSITE RESULTS
          HC   GRAMS/KM (GRAMS/MILE)       ***** (*****)                   PARTICULATE RATE
          CO   GRAMS/KM (GRAMS/MILE)      ****** (******)                  GRAMS/TEST        1.402
          CO2  GRAMS/KM (GRAMS/MILE)     ******* (*******)                 GRAMS/KG FUEL     1.56
          NOX  GRAMS/KM (GRAMS/MILE)       ***** (*****)                   GRAMS/KM         ******
                                                                           GRAMS/MILE       ******

          TOTAL DISTANCE  KM (MILES)        .001 (  .00)
          FUEL CONSUMPTION  KG (LB)         .898 ( 1.981)                  FILTER EFF.     85.43
          FUEL ECONOMY  L/100KM (MPG)     ****** (  .00)
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TABLE D-9. IDLE VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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TEST NO.   1        RUN   1                    VEHICLE NO. 2162                TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    11/29/84                ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                 DIESEL    EM-597-F
TRANSMISSION A-3                               DYNO NO.      4                 ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 737.62 MM HG(29.04 IN HG)            DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
RELATIVE HUMIDITY  41. PCT                     ABS. HUMIDITY  7.8 GM/KG        NOX HUMIDITY CORRECTION FACTOR   .95

BAG RESULTS
   TEST CYCLE                                      IDLE

   RUN TIME                 SECONDS                900.0
   TOT. BLOWER RATE SCMM (SCFM)                 86.05 ( 3038.4)
   TOT. 20X20 RATE SCMM (SCFM)                   3.23 (114.1)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 ( 1.00)
   TOT FLOW STD. CU. METRES(SCF)               1339.6 ( 47303.)

   HC  SAMPLE METER/RANGE/PPM                   18.4/21/ 9.18
   HC  BCKGRD METER/RANGE/PPM                    6.5/ 1/ 3.25
   CO  SAMPLE METER/RANGE/PPM                    4.6/13/ 4.09
   CO  BCKGRD METER/RANGE/PPM                     .8/13/  .71
   CO2 SAMPLE METER/RANGE/PCT                   77.2/13/.1599
   CO2 BCKGRD METER/RANGE/PCT                   24.1/13/.0447
   NOX SAMPLE METER/RANGE/PPM                   21.7/12/21.71
   NOX BCKGRD METER/RANGE/PPM                    2.5/ 1/  .74
   DILUTION FACTOR                                  83.11

   HC  CONCENTRATION PPM                            5.97
   CO  CONCENTRATION PPM                            3.33
   CO2 CONCENTRATION PCT                           .1157
   NOX CONCENTRATION PPM                           20.98
   HC  MASS GRAMS                                  4.608
   CO  MASS GRAMS                                  5.197
   CO2 MASS GRAMS                                2837.77
   NOX MASS GRAMS                                 51.070
   MASS OF FUEL BURNED GRAMS                     898.26
   MEASURED DISTANCE  KM (MILES)                .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)                ****** (  .002)

   HC   GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO   GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO2  GRAMS/KM (GRAMS/MILE)                 ****** (******)
   NOX  GRAMS/KM (GRAMS/MILE)                  ***** (******)


                                                 IDLE   COMPOSITE RESULTS
                  HC    GRAMS/KM (GRAMS/MILE)    ***** (*****)                   PARTICULATE RATE
                  CO    GRAMS/KM (GRAMS/MILE)   ****** (******)                  GRAMS/TEST        1.402
                  CO2   GRAMS/KM (GRAMS/MILE)  ******* (*******)                 GRAMS/KG FUEL     1.56
      CONTINUOUS  NOX   GRAMS/KM (GRAMS/MILE)    ***** (*****)                   GRAMS/KM        ******
                                                                                 GRAMS/MILE      ******

                  TOTAL DISTANCE  KM (MILES)      .001 (  .00)
                  FUEL CONSUMPTION  KG (LB)       .898 ( 1.981)                  FILTER EFF.     85.43
                  FUEL ECONOMY  L/100KM (MPG)   ****** (  .00)
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                    TABLE D-10. IDLE   VEHICLE EMISSIONS RESULTS
                                         PROJECT 03-5428-001

TEST NO.   2         RUN   1
VEHICLE MODEL 1983 GMC RTSII 04              VEHICLE NO. 2162
ENGINE  9.0 L( 552. CID) V-6                 DATE    11/30/84                  TEST WEIGHT 13608. KG(30000. LBS)
TRANSMISSION A-3                             BAG CART NO.  1                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
GVW16738. KG(36900. LBS)                     DYNO NO.       4                  DIESEL      EM-597-F
                                             CVS NO.       11                  ODOMETER  88619. KM( 55065. MILES)

BAROMETER 741.93 MM HG(29.21 IN HG)          DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)
RELATIVE HUMIDITY  29. PCT                   ABS. HUMIDITY  4.4 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .90

BAG RESULTS
   TEST CYCLE
                                               IDLE

   RUN TIME                   SECONDS          900.1
   TOT. BLOWER RATE SCMM (SCFM)              86.56 ( 3056.6)
   TOT. 20X20 RATE SCMM (SCFM)                3.25 (114.8)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)           .03 (  .96)
   TOT FLOW STD. CU. METRES(SCF)            1347.8 ( 47590.)

   HC  SAMPLE METER/RANGE/PPM                20.3/21/10.17
   HC  BCKGRD METER/RANGE/PPM                 8.5/ 1/ 4.25
   CO  SAMPLE METER/RANGE/PPM                 4.2/13/ 3.73
   CO  BCKGRD METER/RANGE/PPM                  .4/13/  .35
   CO2 SAMPLE METER/RANGE/PCT                71.7/13/.1468
   CO2 BCKGRD METER/RANGE/PCT                19.8/13/.0362
   NOX SAMPLE METER/RANGE/PPM                68.9/ 1/20.49
   NOX BCKGRD METER/RANGE/PPM                 1.1/ 1/  .32
   DILUTION FACTOR                              90.42

   HC  CONCENTRATION PPM                         5.96
   CO  CONCENTRATION PPM                         3.34
   CO2 CONCENTRATION PCT                         .1110
   NOX CONCENTRATION PPM                        20.17
   HC  MASS GRAMS                                4.635
   CO  MASS GRAMS                                5.241
   CO2 MASS GRAMS                             2738.79
   NOX MASS GRAMS                               46.668
   MASS OF FUEL BURNED GRAMS                   867.23
   MEASURED DISTANCE  KM (MILES)              .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)              ****** (  .002)

   HC   GRAMS/KM (GRAMS/MILE)               ****** (******)
   CO   GRAMS/KM (GRAMS/MILE)               ****** (******)
   CO2  GRAMS/KM (GRAMS/MILE)               ****** (******)
   NOX  GRAMS/KM (GRAMS/MILE)                ***** (******)


                                                 IDLE   COMPOSITE RESULTS
          HC    GRAMS/KM (GRAMS/MILE)          *****  (*****)
          CO    GRAMS/KM (GRAMS/MILE)         ******  (******)               PARTICULATE RATE
          CO2   GRAMS/KM (GRAMS/MILE)        *******  (*******)              GRAMS/TEST         1.294
          NOX   GRAMS/KM (GRAMS/MILE)          *****  (*****)                GRAMS/KG FUEL      1.49
                                                                             GRAMS/KM         ******
                                                                             GRAMS/MILE       ******

          TOTAL DISTANCE  KM (MILES)         .001 (  .00)
          FUEL CONSUMPTION  KG (LB)          .867 ( 1.912)                   FILTER EFF.      84.18
          FUEL ECONOMY  L/100KM (MPG)      ****** (  .00)
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TABLE D-10. IDLE VEHICLE EMISSIONS RESULTS (Cont'd)

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                                     PROJECT 03-5428-001

TEST NO.    2      RUN   1                   VEHICLE NO. 2162                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE    11/30/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                   DIESEL     EM-597-F
TRANSMISSION A-3                             DYNO NO.      4                   ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.      11

BAROMETER 741.93 MM HG(29.21 IN HG)          DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)
RELATIVE HUMIDITY  29. PCT                   ABS. HUMIDITY  4.4 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .90

BAG RESULTS
   TEST CYCLE                                   IDLE

   RUN TIME               SECONDS              900.1
   TOT. BLOWER RATE SCMM (SCFM)             86.56 ( 3056.6)
   TOT. 20X20 RATE SCMM (SCFM)               3.25 (114.8)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)          .03 (  .96)
   TOT FLOW STD. CU. METRES(SCF)           1347.8 ( 47590.)

   HC   SAMPLE METER/RANGE/PPM              20.3/21/10.17
   HC   BCKGRD METER/RANGE/PPM               8.5/ 1/ 4.25
   CO   SAMPLE METER/RANGE/PPM               4.2/13/ 3.73
   CO   BCKGRD METER/RANGE/PPM                .4/13/  .35
   CO2  SAMPLE METER/RANGE/PCT              71.7/13/.1468
   CO2  BCKGRD METER/RANGE/PCT              19.8/13/.0362
   NOX  SAMPLE METER/RANGE/PPM              21.7/12/21.69
   NOX  BCKGRD METER/RANGE/PPM               1.1/ 1/  .32
   DILUTION FACTOR                             90.42

   HC   CONCENTRATION PPM                       5.96
   CO   CONCENTRATION PPM                       3.34
   CO2  CONCENTRATION PCT                      .1110
   NOX  CONCENTRATION PPM                      21.38
   HC   MASS GRAMS                             4.635
   CO   MASS GRAMS                             5.241
   CO2  MASS GRAMS                           2738.79
   NOX  MASS GRAMS                            49.454
   MASS OF FUEL BURNED GRAMS                  867.23
   MEASURED DISTANCE  KM (MILES)           .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)           ****** (  .002)

   HC    GRAMS/KM (GRAMS/MILE)           ****** (******)
   CO    GRAMS/KM (GRAMS/MILE)           ****** (******)
   CO2   GRAMS/KM (GRAMS/MILE)           ****** (******)
   NOX   GRAMS/KM (GRAMS/MILE)            ***** (******)

                                                  IDLE   COMPOSITE RESULTS
                    HC   GRAMS/KM (GRAMS/MILE)    ***** (*****)                  PARTICULATE RATE
                    CO   GRAMS/KM (GRAMS/MILE)   ****** (******)                 GRAMS/TEST        1.294
                    CO2  GRAMS/KM (GRAMS/MILE)  ******* (*******)                GRAMS/KG FUEL     1.49
        CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)    ***** (*****)                  GRAMS/KM        ******
                                                                                 GRAMS/MILE      ******

                    TOTAL DISTANCE  KM (MILES)      .001 (  .00)
                    FUEL CONSUMPTION  KG (LB)       .867 ( 1.912)                FILTER EFF.     84.18
                    FUEL ECONOMY  L/100KM (MPG)   ****** (  .00)
```

TABLE D-11. 12.5SS VEHICLE EMISSIONS RESULTS

```
                                       PROJECT 03-5428-001

TEST NO.    1        RUN    1              VEHICLE NO. 2162                    TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE    11/29/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1                     DIESEL     EM-597-F
TRANSMISSION A-3                           DYNO NO.       4                    ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.       11

BAROMETER 736.85 MM HG(29.01 IN HG)        DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
RELATIVE HUMIDITY  43. PCT                 ABS. HUMIDITY  7.7 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .95

BAG RESULTS
  TEST CYCLE                                  12.5SS

  RUN TIME                  SECONDS           900.0
  TOT. BLOWER RATE SCMM (SCFM)              85.96 ( 3035.1)
  TOT. 20X20 RATE SCMM (SCFM)                3.23 (113.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)           .03 (   .94)
  TOT FLOW STD. CU. METRES(SCF)            1338.1 ( 47250.)

  HC   SAMPLE METER/RANGE/PPM               32.5/21/16.27
  HC   BCKGRD METER/RANGE/PPM               11.0/ 1/ 5.50
  CO   SAMPLE METER/RANGE/PPM                6.3/13/ 5.61
  CO   BCKGRD METER/RANGE/PPM                 .5/13/  .44
  CO2  SAMPLE METER/RANGE/PCT               61.8/12/.2503
  CO2  BCKGRD METER/RANGE/PCT               12.8/12/.0436
  NOX  SAMPLE METER/RANGE/PPM               92.9/ 1/27.63
  NOX  BCKGRD METER/RANGE/PPM                1.1/ 1/  .32
  DILUTION FACTOR                              53.08

  HC   CONCENTRATION PPM                       10.88
  CO   CONCENTRATION PPM                        5.08
  CO2  CONCENTRATION PCT                       .2075
  NOX  CONCENTRATION PPM                       27.32
  HC   MASS GRAMS                              8.392
  CO   MASS GRAMS                              7.912
  CO2  MASS GRAMS                            5084.35
  NOX  MASS GRAMS                             66.229
  MASS OF FUEL BURNED GRAMS                  1608.84
  MEASURED DISTANCE  KM (MILES)           5.128 (3.187)
  FUEL ECONOMY  L/100KM (MPG)             37.08 ( 6.344)

  HC    GRAMS/KM (GRAMS/MILE)               1.64 (   2.63)
  CO    GRAMS/KM (GRAMS/MILE)               1.54 (   2.48)
  CO2   GRAMS/KM (GRAMS/MILE)              991.4 (1595.2)
  NOX   GRAMS/KM (GRAMS/MILE)              12.91 ( 20.78)


                                           12.5SS COMPOSITE RESULTS
              HC    GRAMS/KM (GRAMS/MILE)     1.64 ( 2.63)                 PARTICULATE RATE
              CO    GRAMS/KM (GRAMS/MILE)     1.54 (   2.48)               GRAMS/TEST         2.574
              CO2   GRAMS/KM (GRAMS/MILE)   991.41 (1595.18)               GRAMS/KG FUEL      1.60
              NOX   GRAMS/KM (GRAMS/MILE)    12.91 (20.78)                 GRAMS/KM            .50
                                                                           GRAMS/MILE          .81

              TOTAL DISTANCE  KM (MILES)     5.128 ( 3.19)
              FUEL CONSUMPTION  KG (LB)      1.609 ( 3.547)                FILTER EFF.     83.55
              FUEL ECONOMY  L/100KM (MPG)    37.08 ( 6.34)
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TABLE D-11. 12.5SS VEHICLE EMISSIONS RESULTS (Cont'd)

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                                   PROJECT 03-5428-001

TEST NO.   1        RUN   1             VEHICLE NO. 2162                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04         DATE    11/29/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6            BAG CART NO.  1                  DIESEL     EM-597-F
TRANSMISSION A-3                        DYNO NO.      4                  ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                CVS NO.      11

BAROMETER 736.85 MM HG(29.01 IN HG)     DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
RELATIVE HUMIDITY  43. PCT              ABS. HUMIDITY  7.7 GM/KG         NOX HUMIDITY CORRECTION FACTOR   .95

BAG RESULTS
  TEST CYCLE                                12.5SS

  RUN TIME                 SECONDS           900.0
  TOT. BLOWER RATE SCMM (SCFM)            85.96 ( 3035.1)
  TOT. 20X20 RATE SCMM (SCFM)              3.23 (113.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)         .03 (   .94)
  TOT FLOW STD. CU. METRES(SCF)          1338.1 ( 47250.)

  HC  SAMPLE METER/RANGE/PPM              32.5/21/16.27
  HC  BCKGRD METER/RANGE/PPM              11.0/ 1/ 5.50
  CO  SAMPLE METER/RANGE/PPM               6.3/13/ 5.61
  CO  BCKGRD METER/RANGE/PPM                .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT              61.8/12/.2503
  CO2 BCKGRD METER/RANGE/PCT              12.8/12/.0436
  NOX SAMPLE METER/RANGE/PPM              30.6/12/30.58
  NOX BCKGRD METER/RANGE/PPM               1.1/ 1/  .32
  DILUTION FACTOR                              53.08

  HC  CONCENTRATION PPM                       10.88
  CO  CONCENTRATION PPM                        5.08
  CO2 CONCENTRATION PCT                       .2075
  NOX CONCENTRATION PPM                       30.26
  HC  MASS GRAMS                               8.392
  CO  MASS GRAMS                               7.912
  CO2 MASS GRAMS                            5084.35
  NOX MASS GRAMS                              73.374
  MASS OF FUEL BURNED GRAMS                 1608.84
  MEASURED DISTANCE  KM (MILES)           5.128 (3.187)
  FUEL ECONOMY  L/100KM (MPG)            37.08 ( 6.344)

  HC    GRAMS/KM (GRAMS/MILE)              1.64 (  2.63)
  CO    GRAMS/KM (GRAMS/MILE)              1.54 (  2.48)
  CO2   GRAMS/KM (GRAMS/MILE)             991.4 (1595.2)
  NOX   GRAMS/KM (GRAMS/MILE)             14.31 ( 23.02)

                                              12.5SS COMPOSITE RESULTS
                 HC   GRAMS/KM (GRAMS/MILE)    1.64 ( 2.63)              PARTICULATE RATE
                 CO   GRAMS/KM (GRAMS/MILE)    1.54 (  2.48)             GRAMS/TEST       2.574
                 CO2  GRAMS/KM (GRAMS/MILE)  991.41 (1595.18)            GRAMS/KG FUEL     1.60
    CONTINUOUS   NOX  GRAMS/KM (GRAMS/MILE)   14.31 (23.02)              GRAMS/KM           .50
                                                                         GRAMS/MILE         .81


                 TOTAL DISTANCE  KM (MILES)     5.128 ( 3.19)
                 FUEL CONSUMPTION  KG (LB)      1.609 ( 3.547)           FILTER EFF.     83.55
                 FUEL ECONOMY  L/100KM (MPG)    37.08 ( 6.34)
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TABLE D-12. 12.5SS VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   2       RUN   1                    VEHICLE NO. 2162                TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04               DATE   11/30/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                  BAG CART NO.  1                 DIESEL     EM-597-F
TRANSMISSION A-3                              DYNO NO.      4                 ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                      CVS NO.      11

BAROMETER 741.43 MM HG(29.19 IN HG)           DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  27. PCT                    ABS. HUMIDITY  4.2 GM/KG        NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
  TEST CYCLE                                     12.5SS

  RUN TIME              SECONDS                  900.1
  TOT. BLOWER RATE SCMM (SCFM)                 86.51 ( 3054.7)
  TOT. 20X20 RATE SCMM (SCFM)                   3.25 (114.7)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (  .96)
  TOT FLOW STD. CU. METRES(SCF)               1346.9 ( 47560.)

  HC  SAMPLE METER/RANGE/PPM                  29.8/21/14.89
  HC  BCKGRD METER/RANGE/PPM                   8.0/ 1/ 4.00
  CO  SAMPLE METER/RANGE/PPM                   6.2/13/ 5.52
  CO  BCKGRD METER/RANGE/PPM                    .4/13/  .35
  CO2 SAMPLE METER/RANGE/PCT                  60.4/12/.2435
  CO2 BCKGRD METER/RANGE/PCT                  11.2/12/.0379
  NOX SAMPLE METER/RANGE/PPM                  30.3/ 2/30.30
  NOX BCKGRD METER/RANGE/PPM                    .5/ 2/  .50
  DILUTION FACTOR                                54.58

  HC  CONCENTRATION PPM                          10.97
  CO  CONCENTRATION PPM                           5.10
  CO2 CONCENTRATION PCT                          .2063
  NOX CONCENTRATION PPM                          29.81
  HC  MASS GRAMS                                  8.518
  CO  MASS GRAMS                                  8.005
  CO2 MASS GRAMS                               5087.04
  NOX MASS GRAMS                                 68.659
  MASS OF FUEL BURNED GRAMS                    1609.85
  MEASURED DISTANCE  KM (MILES)               5.222 (3.245)
  FUEL  ECONOMY  L/100KM (MPG)                36.44 ( 6.456)

  HC   GRAMS/KM (GRAMS/MILE)                   1.63 (  2.62)
  CO   GRAMS/KM (GRAMS/MILE)                   1.53 (  2.47)
  CO2  GRAMS/KM (GRAMS/MILE)                  974.2 (1567.4)
  NOX  GRAMS/KM (GRAMS/MILE)                  13.15 ( 21.16)


                                             12.5SS COMPOSITE RESULTS
                 HC   GRAMS/KM (GRAMS/MILE)    1.63 ( 2.62)                 PARTICULATE RATE
                 CO   GRAMS/KM (GRAMS/MILE)    1.53 (  2.47)                GRAMS/TEST         2.750
                 CO2  GRAMS/KM (GRAMS/MILE)  974.16 (1567.43)               GRAMS/KG FUEL     1.71
                 NOX  GRAMS/KM (GRAMS/MILE)   13.15 (21.16)                 GRAMS/KM           .53
                                                                            GRAMS/MILE         .85


                 TOTAL DISTANCE  KM (MILES)     5.222 ( 3.25)
                 FUEL CONSUMPTION  KG (LB)      1.610 ( 3.550)              FILTER EFF.     87.47
                 FUEL ECONOMY  L/100KM (MPG)    36.44 ( 6.46)
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TABLE D-12. 12.5SS VEHICLE EMISSIONS RESULTS (Cont'd)

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                                PROJECT 03-5428-001

TEST NO.   2          RUN   1                     VEHICLE NO. 2162                      TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSI! 04                   DATE    11/30/84                      ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                      BAG CART NO.  1                       DIESEL     EM-597-F
TRANSMISSION A-3                                  DYNO NO.      4                       ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                          CVS NO.      11

BAROMETER 741.43 MM HG(29.19 IN HG)               DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  27. PCT                        ABS. HUMIDITY  4.2 GM/KG              NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
   TEST CYCLE                                        12.5SS

   RUN TIME                 SECONDS                  900.1
   TOT. BLOWER RATE SCMM (SCFM)                   86.51 ( 3054.7)
   TOT. 20X20 RATE SCMM (SCFM)                     3.25 (114.7)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)                .03 (   .96)
   TOT FLOW STD. CU. METRES(SCF)                1346.9 ( 47560.)

   HC  SAMPLE METER/RANGE/PPM                    29.8/21/14.89
   HC  BCKGRD METER/RANGE/PPM                     8.0/ 1/ 4.00
   CO  SAMPLE METER/RANGE/PPM                     6.2/13/ 5.52
   CO  BCKGRD METER/RANGE/PPM                      .4/13/  .35
   CO2 SAMPLE METER/RANGE/PCT                    60.4/12/.2435
   CO2 BCKGRD METER/RANGE/PCT                    11.2/12/.0379
   NOX SAMPLE METER/RANGE/PPM                    31.5/12/31.47
   NOX BCKGRD METER/RANGE/PPM                      .5/ 2/  .50
   DILUTION FACTOR                                   54.58

   HC  CONCENTRATION PPM                             10.97
   CO  CONCENTRATION PPM                              5.10
   CO2 CONCENTRATION PCT                             .2063
   NOX CONCENTRATION PPM                             30.98
   HC  MASS GRAMS                                     8.518
   CO  MASS GRAMS                                     8.005
   CO2 MASS GRAMS                                  5087.04
   NOX MASS GRAMS                                    71.350
   MASS OF FUEL BURNED GRAMS                       1609.85
   MEASURED DISTANCE  KM (MILES)                  5.222 (3.245)
   FUEL ECONOMY  L/100KM (MPG)                    36.44 ( 6.456)

   HC   GRAMS/KM (GRAMS/MILE)                      1.63 (  2.62)
   CO   GRAMS/KM (GRAMS/MILE)                      1.53 (  2.47)
   CO2  GRAMS/KM (GRAMS/MILE)                     974.2 (1567.4)
   NOX  GRAMS/KM (GRAMS/MILE)                     13.66 ( 21.98)

                                                  12.5SS COMPOSITE RESULTS
                     HC   GRAMS/KM (GRAMS/MILE)      1.63 ( 2.62)                 PARTICULATE RATE
                     CO   GRAMS/KM (GRAMS/MILE)      1.53 (  2.47)                GRAMS/TEST        2.750
                     CO2  GRAMS/KM (GRAMS/MILE)    974.16 (1567.43)               GRAMS/KG FUEL     1.71
          CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)     13.66 (21.98)                 GRAMS/KM           .53
                                                                                  GRAMS/MILE         .85

                     TOTAL DISTANCE  KM (MILES)     5.222 ( 3.25)
                     FUEL CONSUMPTION  KG (LB)      1.610 ( 3.550)                FILTER EFF.     87.47
                     FUEL ECONOMY  L/100KM (MPG)    36.44 ( 6.46)
```

TABLE D-13. 25 MPH VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   1        RUN   1                   VEHICLE NO. 2162                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04               DATE    11/29/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                  BAG CART NO.  1                   DIESEL     EM-597-F
TRANSMISSION A-3                              DYNO NO.      4                   ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                      CVS NO.      11

BAROMETER 736.60 MM HG(29.00 IN HG)           DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  60. PCT                    ABS. HUMIDITY  9.7 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .98

BAG RESULTS
   TEST CYCLE                                    25 MPH

   RUN TIME                  SECONDS              900.0
   TOT. BLOWER RATE SCMM (SCFM)                 85.93 ( 3034.3)
   TOT. 20X20 RATE SCMM (SCFM)                   3.22 (113.9)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (   .94)
   TOT FLOW STD. CU. METRES(SCF)               1337.8 ( 47237.)

   HC  SAMPLE METER/RANGE/PPM                   36.8/21/18.42
   HC  BCKGRD METER/RANGE/PPM                   12.0/ 1/ 6.00
   CO  SAMPLE METER/RANGE/PPM                    7.6/13/ 6.78
   CO  BCKGRD METER/RANGE/PPM                     .6/13/  .53
   CO2 SAMPLE METER/RANGE/PCT                   82.8/12/.3606
   CO2 BCKGRD METER/RANGE/PCT                   11.7/12/.0396
   NOX SAMPLE METER/RANGE/PPM                   36.8/ 2/36.80
   NOX BCKGRD METER/RANGE/PPM                     .1/ 2/  .10
   DILUTION FACTOR                                36.91

   HC  CONCENTRATION PPM                        12.58
   CO  CONCENTRATION PPM                         6.10
   CO2 CONCENTRATION PCT                         .3220
   NOX CONCENTRATION PPM                        36.70
   HC  MASS GRAMS                                9.703
   CO  MASS GRAMS                                9.493
   CO2 MASS GRAMS                             7886.84
   NOX MASS GRAMS                               92.166
   MASS OF FUEL BURNED GRAMS                  2490.94
   MEASURED DISTANCE  KM (MILES)              ***** (6.366)
   FUEL ECONOMY  L/100KM (MPG)                 28.74 ( 8.184)

   HC   GRAMS/KM (GRAMS/MILE)                    .95 (  1.52)
   CO   GRAMS/KM (GRAMS/MILE)                    .93 (  1.49)
   CO2  GRAMS/KM (GRAMS/MILE)                  770.0 (1239.0)
   NOX  GRAMS/KM (GRAMS/MILE)                   9.00 ( 14.48)

                                               25 MPH COMPOSITE RESULTS
           HC   GRAMS/KM (GRAMS/MILE)           .95 ( 1.52)                   PARTICULATE RATE
           CO   GRAMS/KM (GRAMS/MILE)           .93 (  1.49)                  GRAMS/TEST        4.716
           CO2  GRAMS/KM (GRAMS/MILE)        770.02 (1238.97)                 GRAMS/KG FUEL     1.89
           NOX  GRAMS/KM (GRAMS/MILE)          9.00 (14.48)                   GRAMS/KM           .46
                                                                              GRAMS/MILE         .74

           TOTAL DISTANCE  KM (MILES)        ***** ( 6.37)
           FUEL CONSUMPTION  KG (LB)          2.491 ( 5.493)                  FILTER EFF.     87.70
           FUEL ECONOMY  L/100KM (MPG)       28.74 ( 8.18)
```

TABLE D-13. 25 MPH VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

```
TEST NO.   1         RUN   1
VEHICLE MODEL 1983 GMC RTSII 04              VEHICLE NO. 2162                    TEST WEIGHT 13608. KG(30000. LBS)
ENGINE  9.0 L( 552. CID) V-6                 DATE    11/29/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
TRANSMISSION A-3                             BAG CART NO.  1                     DIESEL     EM-597-F
GVW16738. KG(36900. LBS)                     DYNO NO.      4                     ODOMETER  88619. KM( 55065. MILES)
                                             CVS NO.      11

BAROMETER 736.60 MM HG(29.00 IN HG)          DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  60. PCT                   ABS. HUMIDITY  9.7 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .98

BAG RESULTS
  TEST CYCLE                                   25 MPH

  RUN TIME                  SECONDS            900.0
  TOT. BLOWER RATE SCMM (SCFM)               85.93 ( 3034.3)
  TOT. 20X20 RATE SCMM (SCFM)                 3.22 (113.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (  .94)
  TOT FLOW STD. CU. METRES(SCF)             1337.8 ( 47237.)

  HC   SAMPLE METER/RANGE/PPM                 36.8/21/18.42
  HC   BCKGRD METER/RANGE/PPM                 12.0/ 1/ 6.00
  CO   SAMPLE METER/RANGE/PPM                  7.6/13/ 6.78
  CO   BCKGRD METER/RANGE/PPM                   .6/13/  .53
  CO2  SAMPLE METER/RANGE/PCT                 82.8/12/.3606
  CO2  BCKGRD METER/RANGE/PCT                 11.7/12/.0396
  NOX  SAMPLE METER/RANGE/PPM                 39.3/12/39.33
  NOX  BCKGRD METER/RANGE/PPM                   .1/ 2/  .10
  DILUTION FACTOR                               36.91

  HC   CONCENTRATION PPM                        12.58
  CO   CONCENTRATION PPM                         6.10
  CO2  CONCENTRATION PCT                        .3220
  NOX  CONCENTRATION PPM                        39.23
  HC   MASS GRAMS                                9.703
  CO   MASS GRAMS                                9.493
  CO2  MASS GRAMS                             7886.84
  NOX  MASS GRAMS                               98.514
  MASS OF FUEL BURNED GRAMS                   2490.94
  MEASURED DISTANCE  KM (MILES)              ***** (6.366)
  FUEL ECONOMY  L/100KM (MPG)                28.74 ( 8.184)

  HC   GRAMS/KM (GRAMS/MILE)                   .95 (  1.52)
  CO   GRAMS/KM (GRAMS/MILE)                   .93 (  1.49)
  CO2  GRAMS/KM (GRAMS/MILE)                 770.0 (1239.0)
  NOX  GRAMS/KM (GRAMS/MILE)                  9.62 ( 15.48)

                                              25 MPH COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)     .95 ( 1.52)                       PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)     .93 (  1.49)                      GRAMS/TEST        4.716
                CO2  GRAMS/KM (GRAMS/MILE)  770.02 (1238.97)                     GRAMS/KG FUEL     1.89
     CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)    9.62 (15.48)                       GRAMS/KM           .46
                                                                                 GRAMS/MILE         .74

                TOTAL DISTANCE  KM (MILES)     ***** ( 6.37)
                FUEL CONSUMPTION  KG (LB)      2.491 ( 5.493)                    FILTER EFF.     87.70
                FUEL ECONOMY  L/100KM (MPG)    28.74 ( 8.18)
```

TABLE D-14. 25 SS VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   2          RUN   1                   VEHICLE NO. 2162                      TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                 DATE     11/30/84                     ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                    BAG CART NO.  1                       DIESEL     EM-597-F
TRANSMISSION A-3                                DYNO NO.       4                      ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                        CVS NO.       11

BAROMETER 741.43 MM HG(29.19 IN HG)             DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  23. PCT                      ABS. HUMIDITY  3.7 GM/KG              NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
   TEST CYCLE                                      25 SS

   RUN TIME              SECONDS                  900.1
   TOT. BLOWER RATE SCMM (SCFM)                 86.47 ( 3053.4)
   TOT. 20X20 RATE SCMM (SCFM)                   3.25 (114.7)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (  .95)
   TOT FLOW STD. CU. METRES(SCF)               1346.4 ( 47541.)

   HC  SAMPLE METER/RANGE/PPM                   35.1/21/17.56
   HC  BCKGRD METER/RANGE/PPM                    9.0/ 1/ 4.50
   CO  SAMPLE METER/RANGE/PPM                    7.5/13/ 6.69
   CO  BCKGRD METER/RANGE/PPM                     .3/13/  .27
   CO2 SAMPLE METER/RANGE/PCT                   81.9/12/.3555
   CO2 BCKGRD METER/RANGE/PCT                   11.2/12/.0379
   NOX SAMPLE METER/RANGE/PPM                   39.2/ 2/39.20
   NOX BCKGRD METER/RANGE/PPM                     .3/ 2/  .30
   DILUTION FACTOR                                  37.44

   HC  CONCENTRATION PPM                          13.18
   CO  CONCENTRATION PPM                           6.34
   CO2 CONCENTRATION PCT                           .3186
   NOX CONCENTRATION PPM                          38.91
   HC  MASS GRAMS                                 10.231
   CO  MASS GRAMS                                  9.935
   CO2 MASS GRAMS                               7854.17
   NOX MASS GRAMS                                 88.804
   MASS OF FUEL BURNED GRAMS                    2481.43
   MEASURED DISTANCE  KM (MILES)               ***** (6.387)
   FUEL ECONOMY  L/100KM (MPG)                 28.54 ( 8.243)

   HC   GRAMS/KM (GRAMS/MILE)                   1.00 (  1.60)
   CO   GRAMS/KM (GRAMS/MILE)                    .97 (  1.56)
   CO2  GRAMS/KM (GRAMS/MILE)                  764.3 (1229.7)
   NOX  GRAMS/KM (GRAMS/MILE)                   8.64 ( 13.90)

                                                25 SS  COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)     1.00 ( 1.60)                      PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)      .97 (  1.56)                     GRAMS/TEST        4.798
                CO2  GRAMS/KM (GRAMS/MILE)   764.27 (1229.71)                    GRAMS/KG FUEL     1.93
                NOX  GRAMS/KM (GRAMS/MILE)     8.64 (13.90)                      GRAMS/KM           .47
                                                                                 GRAMS/MILE         .75

                TOTAL DISTANCE  KM (MILES)     ***** ( 6.39)
                FUEL CONSUMPTION  KG (LB)      2.481 ( 5.472)                    FILTER EFF.     89.83
                FUEL ECONOMY  L/100KM (MPG)    28.54 ( 8.24)
```

TABLE D-14. 25 SS VEHICLE EMISSIONS RESULTS (Cont'd)

```
                                        PROJECT 03-5428-001

TEST NO.   2        RUN   1                    VEHICLE NO. 2162                   TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    11/30/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                    DIESEL     EM-597-F
TRANSMISSION A-3                               DYNO NO.      4                    ODOMETER  88619. KM( 55065. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 741.43 MM HG(29.19 IN HG)            DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  23. PCT                     ABS. HUMIDITY  3.7 GM/KG           NOX HUMIDITY CORRECTION FACTOR   .89

BAG RESULTS
  TEST CYCLE                                     25 SS

  RUN TIME                    SECONDS            900.1
  TOT. BLOWER RATE SCMM (SCFM)               86.47 ( 3053.4)
  TOT. 20X20 RATE SCMM (SCFM)                 3.25 (114.7)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (  .95)
  TOT FLOW STD. CU. METRES(SCF)             1346.4 ( 47541.)

  HC   SAMPLE METER/RANGE/PPM                 35.1/21/17.56
  HC   BCKGRD METER/RANGE/PPM                  9.0/ 1/ 4.50
  CO   SAMPLE METER/RANGE/PPM                  7.5/13/ 6.69
  CO   BCKGRD METER/RANGE/PPM                   .3/13/  .27
  CO2  SAMPLE METER/RANGE/PCT                 81.9/12/.3555
  CO2  BCKGRD METER/RANGE/PCT                 11.2/12/.0379
  NOX  SAMPLE METER/RANGE/PPM                 40.9/12/40.91
  NOX  BCKGRD METER/RANGE/PPM                   .3/ 2/  .30
  DILUTION FACTOR                               37.44

  HC   CONCENTRATION PPM                         13.18
  CO   CONCENTRATION PPM                          6.34
  CO2  CONCENTRATION PCT                         .3186
  NOX  CONCENTRATION PPM                         40.62
  HC   MASS GRAMS                                10.231
  CO   MASS GRAMS                                 9.935
  CO2  MASS GRAMS                              7854.17
  NOX  MASS GRAMS                                92.701
  MASS OF FUEL BURNED GRAMS                    2481.43
  MEASURED DISTANCE  KM (MILES)              ***** (6.387)
  FUEL ECONOMY  L/100KM (MPG)                28.54 ( 8.243)

  HC    GRAMS/KM (GRAMS/MILE)                 1.00 (  1.60)
  CO    GRAMS/KM (GRAMS/MILE)                  .97 (  1.56)
  CO2   GRAMS/KM (GRAMS/MILE)                764.3 (1229.7)
  NOX   GRAMS/KM (GRAMS/MILE)                 9.02 ( 14.51)

                                              25 SS  COMPOSITE RESULTS
                  HC   GRAMS/KM (GRAMS/MILE)    1.00 ( 1.60)                  PARTICULATE RATE
                  CO   GRAMS/KM (GRAMS/MILE)     .97 (  1.56)                 GRAMS/TEST          4.798
                  CO2  GRAMS/KM (GRAMS/MILE)  764.27 (1229.71)                GRAMS/KG FUEL       1.93
    CONTINUOUS    NOX  GRAMS/KM (GRAMS/MILE)    9.02 (14.51)                  GRAMS/KM             .47
                                                                              GRAMS/MILE           .75

                  TOTAL DISTANCE  KM (MILES)   ***** ( 6.39)
                  FUEL CONSUMPTION  KG (LB)    2.481 ( 5.472)                 FILTER EFF.     89.83
                  FUEL ECONOMY  L/100KM (MPG)  28.54 ( 8.24)
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TABLE D-15. C-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   1          RUN   1                 VEHICLE NO. 2126                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04               DATE    12/ 5/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                  BAG CART NO.  1                   DIESEL     EM-400-F
TRANSMISSION 1-3                              DYNO NO.      4                   ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                      CVS NO.      11

BAROMETER 747.01 MM HG(29.41 IN HG)           DRY BULB TEMP. 13.9 DEG C(57.0 DEG F)
RELATIVE HUMIDITY  46. PCT                    ABS. HUMIDITY  4.6 GM/KG          NOX HUMIDITY CORRECTION FACTOR    .90
BAG RESULTS
  BAG NUMBER                                        1              2              3              4
  DESCRIPTION                                     NYNF           LANF            LAF           NYNF

  RUN TIME                    SECONDS            254.0          285.0          267.0          262.0
  TOT. BLOWER RATE SCMM (SCFM)            257.21 ( 9081.9) 257.20 ( 9081.8) 257.25 ( 9083.5) 257.09 ( 9077.9)
  TOT. 20X20 RATE SCMM (SCFM)               3.28 (115.9)     3.28 (115.9)     3.28 (115.9)     3.28 (115.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)          .04 ( 1.28)      .04 ( 1.28)      .04 ( 1.28)      .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)          1102.9 ( 38943.) 1237.5 ( 43695.) 1159.5 ( 40943.) 1137.1 ( 40152.)

  HC  SAMPLE METER/RANGE/PPM               8.7/21/ 4.37    10.1/21/ 5.03    15.7/21/ 7.85    10.6/21/ 5.30
  HC  BCKGRD METER/RANGE/PPM               5.0/ 1/ 2.50     5.4/ 1/ 2.70     5.8/ 1/ 2.90     6.2/ 1/ 3.10
  CO  SAMPLE METER/RANGE/PPM               6.5/13/ 5.79     7.6/13/ 6.78    11.9/13/10.67     6.1/13/ 5.43
  CO  BCKGRD METER/RANGE/PPM                .1/13/  .09      .3/13/  .27     1.2/13/ 1.06      .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT              59.1/13/.1184    69.2/13/.1410    71.8/12/.3008    56.7/13/.1131
  CO2 BCKGRD METER/RANGE/PCT              21.4/13/.0394    21.4/13/.0394    12.9/12/.0439    21.9/13/.0404
  NOX SAMPLE METER/RANGE/PPM              24.9/ 1/ 7.40    33.3/ 1/ 9.90    76.3/ 1/22.69    30.5/ 1/ 9.07
  NOX BCKGRD METER/RANGE/PPM                .5/ 1/  .14      .7/ 1/  .20     1.9/ 1/  .56     1.4/ 1/  .41
  DILUTION FACTOR                             112.26           94.24           44.29          117.37

  HC  CONCENTRATION PPM                        1.89            2.36            5.01            2.23
  CO  CONCENTRATION PPM                        5.61            6.40            9.43            5.25
  CO2 CONCENTRATION PCT                       .0793           .1021           .2578           .0731
  NOX CONCENTRATION PPM                        7.26            9.70           22.15            8.66
  HC  MASS GRAMS                              1.200           1.681           3.351           1.462
  CO  MASS GRAMS                              7.198           9.224          12.725           6.955
  CO2 MASS GRAMS                            1602.02         2312.48         5473.29         1521.61
  NOX MASS GRAMS                             13.779          20.657          44.190          16.947
  MASS OF FUEL BURNED GRAMS                  510.69          736.53         1738.12          485.43
  MEASURED DISTANCE  KM (MILES)          .731 ( .455)    1.847 (1.148)    5.281 (3.282)     .857 ( .533)
  FUEL ECONOMY  L/100KM (MPG)           85.98 ( 2.736)   49.11 ( 4.790)   40.53 ( 5.804)   69.72 ( 3.374)

  HC   GRAMS/KM (GRAMS/MILE)             1.64 (  2.64)     .91 (  1.46)     .63 (  1.02)    1.71 (  2.74)
  CO   GRAMS/KM (GRAMS/MILE)             9.84 ( 15.83)    4.99 (  8.04)    2.41 (  3.88)    8.11 ( 13.05)
  CO2  GRAMS/KM (GRAMS/MILE)           2190.2 (3524.0)  1252.1 (2014.7)  1036.4 (1667.5)  1774.7 (2855.6)
  NOX  GRAMS/KM (GRAMS/MILE)            18.84 ( 30.31)   11.19 ( 18.00)    8.37 ( 13.46)   19.77 ( 31.80)


                                C-TRAN COMPOSITE RESULTS
             HC   GRAMS/KM (GRAMS/MILE)     .88 ( 1.42)                  PARTICULATE RATE
             CO   GRAMS/KM (GRAMS/MILE)    4.14 (  6.66)                 GRAMS/TEST      10.498
             CO2  GRAMS/KM (GRAMS/MILE) 1251.53 (2013.72)                GRAMS/KG FUEL    3.02
             NOX  GRAMS/KM (GRAMS/MILE)   10.96 (17.64)                  GRAMS/KM         1.20
                                                                         GRAMS/MILE       1.94

             TOTAL DISTANCE  KM (MILES)   8.717 ( 5.42)
             FUEL CONSUMPTION  KG (LB)    3.471 ( 7.653)                 FILTER EFF.     92.61
             FUEL ECONOMY  L/100KM (MPG) 49.03 ( 4.80)
```

TABLE D-15. C-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION 1-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 2126
DATE 12/ 5/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 155496. KM(96621. MILES)

BAROMETER 747.01 MM HG(29.41 IN HG)
RELATIVE HUMIDITY 46. PCT

DRY BULB TEMP. 13.9 DEG C(57.0 DEG F)
ABS. HUMIDITY 4.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .90

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	257.21 (9081.9)	257.20 (9081.8)	257.25 (9083.5)	257.09 (9077.9)
TOT. 20X20 RATE SCMM (SCFM)	3.28 (115.9)	3.28 (115.9)	3.28 (115.9)	3.28 (115.9)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.28)	.04 (1.28)	.04 (1.28)	.04 (1.28)
TOT FLOW STD. CU. METRES(SCF)	1102.9 (38943.)	1237.5 (43695.)	1159.5 (40943.)	1137.1 (40152.)
HC SAMPLE METER/RANGE/PPM	8.7/21/ 4.37	10.1/21/ 5.03	15.7/21/ 7.85	10.6/21/ 5.30
HC BCKGRD METER/RANGE/PPM	5.0/ 1/ 2.50	5.4/ 1/ 2.70	5.8/ 1/ 2.90	6.2/ 1/ 3.10
CO SAMPLE METER/RANGE/PPM	6.5/13/ 5.79	7.6/13/ 6.78	11.9/13/10.67	6.1/13/ 5.43
CO BCKGRD METER/RANGE/PPM	.1/13/ .09	.3/13/ .27	1.2/13/ 1.06	.1/13/ .09
CO2 SAMPLE METER/RANGE/PCT	59.1/13/.1184	69.2/13/.1410	71.8/12/.3008	56.7/13/.1131
CO2 BCKGRD METER/RANGE/PCT	21.4/13/.0394	21.4/13/.0394	12.9/12/.0439	21.9/13/.0404
NOX SAMPLE METER/RANGE/PPM	8.0/12/ 7.99	10.1/12/10.11	23.2/12/23.19	10.4/12/10.44
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ .14	.7/ 1/ .20	1.9/ 1/ .56	1.4/ 1/ .41
DILUTION FACTOR	112.26	94.24	44.29	117.37
HC CONCENTRATION PPM	1.89	2.36	5.01	2.23
CO CONCENTRATION PPM	5.61	6.40	9.43	5.25
CO2 CONCENTRATION PCT	.0793	.1021	.2578	.0731
NOX CONCENTRATION PPM	7.85	9.91	22.65	10.04
HC MASS GRAMS	1.200	1.681	3.351	1.462
CO MASS GRAMS	7.198	9.224	12.725	6.955
CO2 MASS GRAMS	1602.02	2312.48	5473.29	1521.61
NOX MASS GRAMS	14.906	21.097	45.189	19.642
MASS OF FUEL BURNED GRAMS	510.69	736.53	1738.12	485.43
MEASURED DISTANCE KM (MILES)	.731 (.455)	1.847 (1.148)	5.281 (3.282)	.857 (.533)
FUEL ECONOMY L/100KM (MPG)	85.98 (2.736)	49.11 (4.790)	40.53 (5.804)	69.72 (3.374)
HC GRAMS/KM (GRAMS/MILE)	1.64 (2.64)	.91 (1.46)	.63 (1.02)	1.71 (2.74)
CO GRAMS/KM (GRAMS/MILE)	9.84 (15.83)	4.99 (8.04)	2.41 (3.88)	8.11 (13.05)
CO2 GRAMS/KM (GRAMS/MILE)	2190.2 (3524.0)	1252.1 (2014.7)	1036.4 (1667.5)	1774.7 (2855.6)
NOX GRAMS/KM (GRAMS/MILE)	20.38 (32.79)	11.42 (18.38)	8.56 (13.77)	22.91 (36.86)

C-TRAN COMPOSITE RESULTS

	HC GRAMS/KM (GRAMS/MILE)	.88 (1.42)
	CO GRAMS/KM (GRAMS/MILE)	4.14 (6.66)
	CO2 GRAMS/KM (GRAMS/MILE)	1251.53 (2013.72)
CONTINUOUS	NOX GRAMS/KM (GRAMS/MILE)	11.57 (18.61)
	TOTAL DISTANCE KM (MILES)	8.717 (5.42)
	FUEL CONSUMPTION KG (LB)	3.471 (7.653)
	FUEL ECONOMY L/100KM (MPG)	49.03 (4.80)

PARTICULATE RATE

GRAMS/TEST	10.498
GRAMS/KG FUEL	3.02
GRAMS/KM	1.20
GRAMS/MILE	1.94

FILTER EFF. 92.61

TABLE D-16. C-TRAN VEHICLE EMISSIONS RESULTS

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                                          PROJECT 03-5428-001

TEST NO.   2        RUN   1              VEHICLE NO. 2126                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04          DATE   12/ 6/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6             BAG CART NO.  1                  DIESEL    EM-400-F
TRANSMISSION A-3                         DYNO NO.      4                  ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                 CVS NO.      11

BAROMETER 760.22 MM HG(29.93 IN HG)      DRY BULB TEMP. 11.7 DEG C(53.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  41. PCT               ABS. HUMIDITY  3.5 GM/KG
BAG RESULTS
   BAG NUMBER                                  1                  2                  3                  4
   DESCRIPTION                               NYNF               LANF                LAF               NYNF

   RUN TIME                 SECONDS          254.0              285.0              267.0              262.0
 TOT. BLOWER RATE SCMM (SCFM)        262.43 ( 9266.6)   262.35 ( 9263.6)   262.39 ( 9264.9)   262.34 ( 9263.3)
 TOT. 20X20 RATE SCMM (SCFM)           3.36 (118.7)       3.36 (118.7)       3.36 (118.7)       3.36 (118.7)
 TOT. AUX. SAMPLE RATE SCMM (SCFM)      .04 ( 1.28)        .04 ( 1.28)        .04 ( 1.28)        .04 ( 1.28)
 TOT FLOW STD. CU. METRES(SCF)      1125.4 ( 39736.)   1262.3 ( 44572.)   1182.7 ( 41762.)   1160.4 ( 40973.)

 HC   SAMPLE METER/RANGE/PPM          10.7/21/ 5.33      11.6/21/ 5.81      17.4/21/ 8.68      12.4/21/ 6.21
 HC   BCKGRD METER/RANGE/PPM           5.5/ 1/ 2.75       6.2/ 1/ 3.10       6.9/ 1/ 3.45       7.5/ 1/ 3.75
 CO   SAMPLE METER/RANGE/PPM           6.6/13/ 5.88       6.0/13/ 5.34      10.2/13/ 9.13       5.8/13/ 5.16
 CO   BCKGRD METER/RANGE/PPM           1.0/13/  .89        .3/13/  .27        .2/13/  .18        .1/13/  .09
 CO2  SAMPLE METER/RANGE/PCT          61.1/13/.1228      69.1/13/.1408      72.0/12/.3018      54.8/13/.1090
 CO2  BCKGRD METER/RANGE/PCT          21.6/13/.0398      20.7/13/.0380      12.4/12/.0421      21.5/13/.0396
 NOX  SAMPLE METER/RANGE/PPM          27.1/ 1/ 8.05      35.1/ 1/10.43      83.0/ 1/24.68      31.8/ 1/ 9.45
 NOX  BCKGRD METER/RANGE/PPM            .8/ 1/  .23       1.1/ 1/  .32       2.6/ 1/  .77       2.3/ 1/  .68
 DILUTION FACTOR                        108.16              94.43              44.14             121.71

 HC   CONCENTRATION PPM                  2.60               2.74               5.31               2.49
 CO   CONCENTRATION PPM                  4.92               5.00               8.78               5.00
 CO2  CONCENTRATION PCT                  .0834              .1032              .2606              .0697
 NOX  CONCENTRATION PPM                  7.83              10.12              23.94               8.78
 HC   MASS GRAMS                         1.690              1.997              3.622              1.667
 CO   MASS GRAMS                         6.450              7.345             12.092              6.751
 CO2  MASS GRAMS                      1717.76            2385.15            5643.36            1481.35
 NOX  MASS GRAMS                        14.893             21.597             47.870             17.231
 MASS OF FUEL BURNED GRAMS             547.36             758.87            1791.78             472.82
 MEASURED DISTANCE  KM (MILES)         .746 ( .464)      1.836 (1.141)      5.347 (3.323)       .871 ( .541)
 FUEL ECONOMY  L/100KM (MPG)         90.37 ( 2.603)     50.90 ( 4.621)     41.27 ( 5.700)     66.84 ( 3.519)

 HC   GRAMS/KM (GRAMS/MILE)           2.27 (  3.65)      1.09 (  1.75)       .68 (  1.09)      1.91 (  3.08)
 CO   GRAMS/KM (GRAMS/MILE)           8.65 ( 13.91)      4.00 (  6.44)      2.26 (  3.64)      7.75 ( 12.47)
 CO2  GRAMS/KM (GRAMS/MILE)         2302.9 (3705.4)    1299.2 (2090.4)    1055.5 (1698.3)    1700.5 (2736.1)
 NOX  GRAMS/KM (GRAMS/MILE)          19.97 ( 32.13)     11.76 ( 18.93)      8.95 ( 14.41)     19.78 ( 31.83)

                                   C-TRAN COMPOSITE RESULTS
               HC   GRAMS/KM (GRAMS/MILE)    1.02 ( 1.64)                 PARTICULATE RATE
               CO   GRAMS/KM (GRAMS/MILE)    3.71 (  5.97)                GRAMS/TEST       11.051
               CO2  GRAMS/KM (GRAMS/MILE) 1275.95 (2053.01)               GRAMS/KG FUEL     3.09
               NOX  GRAMS/KM (GRAMS/MILE)   11.55 (18.58)                 GRAMS/KM          1.26
                                                                          GRAMS/MILE        2.02

               TOTAL DISTANCE  KM (MILES)     8.799 ( 5.47)               FILTER EFF.     90.63
               FUEL CONSUMPTION  KG (LB)      3.571 ( 7.874)
               FUEL ECONOMY  L/100KM (MPG)    49.97 ( 4.71)
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TABLE D-16.C-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 2 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 2126
DATE 12/ 6/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 155496. KM(96621. MILES)

BAROMETER 760.22 MM HG(29.93 IN HG)
RELATIVE HUMIDITY 41. PCT

DRY BULB TEMP. 11.7 DEG C(53.0 DEG F)
ABS. HUMIDITY 3.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .88

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	262.43 (9266.6)	262.35 (9263.6)	262.39 (9264.9)	262.34 (9263.3)
TOT. 20X20 RATE SCMM (SCFM)	3.36 (118.7)	3.36 (118.7)	3.36 (118.7)	3.36 (118.7)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.28)	.04 (1.28)	.04 (1.28)	.04 (1.28)
TOT FLOW STD. CU. METRES(SCF)	1125.4 (39736.)	1262.3 (44572.)	1182.7 (41762.)	1160.4 (40973.)
HC SAMPLE METER/RANGE/PPM	10.7/21/ 5.33	11.6/21/ 5.81	17.4/21/ 8.68	12.4/21/ 6.21
HC BCKGRD METER/RANGE/PPM	5.5/ 1/ 2.75	6.2/ 1/ 3.10	6.9/ 1/ 3.45	7.5/ 1/ 3.75
CO SAMPLE METER/RANGE/PPM	6.6/13/ 5.88	6.0/13/ 5.34	10.2/13/ 9.13	5.8/13/ 5.16
CO BCKGRD METER/RANGE/PPM	1.0/13/ .89	.3/13/ .27	.2/13/ .18	.1/13/ .09
CO2 SAMPLE METER/RANGE/PCT	61.1/13/.1228	69.1/13/.1408	72.0/12/.3018	54.8/13/.1090
CO2 BCKGRD METER/RANGE/PCT	21.6/13/.0398	20.7/13/.0380	12.4/12/.0421	21.5/13/.0396
NOX SAMPLE METER/RANGE/PPM	8.7/12/ 8.73	11.6/12/11.57	24.4/12/24.38	10.5/12/10.50
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ .23	1.1/ 1/ .32	2.6/ 1/ .77	2.3/ 1/ .68
DILUTION FACTOR	108.16	94.43	44.14	121.71
HC CONCENTRATION PPM	2.60	2.74	5.31	2.49
CO CONCENTRATION PPM	4.92	5.00	8.78	5.00
CO2 CONCENTRATION PCT	.0834	.1032	.2606	.0697
NOX CONCENTRATION PPM	8.50	11.25	23.63	9.83
HC MASS GRAMS	1.690	1.997	3.622	1.667
CO MASS GRAMS	6.450	7.345	12.092	6.751
CO2 MASS GRAMS	1717.76	2385.15	5643.36	1481.35
NOX MASS GRAMS	16.180	24.023	47.258	19.282
MASS OF FUEL BURNED GRAMS	547.36	758.87	1791.78	472.82
MEASURED DISTANCE KM (MILES)	.746 (.464)	1.836 (1.141)	5.347 (3.323)	.871 (.541)
FUEL ECONOMY L/100KM (MPG)	90.37 (2.603)	50.90 (4.621)	41.27 (5.700)	66.84 (3.519)
HC GRAMS/KM (GRAMS/MILE)	2.27 (3.65)	1.09 (1.75)	.68 (1.09)	1.91 (3.08)
CO GRAMS/KM (GRAMS/MILE)	8.65 (13.91)	4.00 (6.44)	2.26 (3.64)	7.75 (12.47)
CO2 GRAMS/KM (GRAMS/MILE)	2302.9 (3705.4)	1299.2 (2090.4)	1055.5 (1698.3)	1700.5 (2736.1)
NOX GRAMS/KM (GRAMS/MILE)	21.69 (34.90)	13.09 (21.05)	8.84 (14.22)	22.13 (35.61)

C-TRAN COMPOSITE RESULTS

HC	GRAMS/KM (GRAMS/MILE)	1.02 (1.64)
CO	GRAMS/KM (GRAMS/MILE)	3.71 (5.97)
CO2	GRAMS/KM (GRAMS/MILE)	1275.95 (2053.01)
CONTINUOUS NOX	GRAMS/KM (GRAMS/MILE)	12.13 (19.52)

TOTAL DISTANCE KM (MILES)	8.799 (5.47)
FUEL CONSUMPTION KG (LB)	3.571 (7.874)
FUEL ECONOMY L/100KM (MPG)	49.97 (4.71)

PARTICULATE RATE	
GRAMS/TEST	11.051
GRAMS/KG FUEL	3.09
GRAMS/KM	1.26
GRAMS/MILE	2.02

FILTER EFF. 90.63

TABLE D-17. H-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 2126
DATE 12/ 5/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 155496. KM(96621. MILES)

BAROMETER 747.78 MM HG(29.44 IN HG)
RELATIVE HUMIDITY 43. PCT

DRY BULB TEMP. 15.0 DEG C(59.0 DEG F)
ABS. HUMIDITY 4.6 GM/KG

NOX HUMIDITY CORRECTION FACTOR .90

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	257.32 (9086.0)	257.28 (9084.7)	257.33 (9086.5)	257.27 (9084.1)
TOT. 20X20 RATE SCMM (SCFM)	3.31 (117.0)	3.31 (117.0)	3.31 (117.0)	3.31 (117.0)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.25)	.04 (1.25)	.04 (1.25)	.04 (1.25)
TOT FLOW STD. CU. METRES(SCF)	1103.5 (38964.)	1238.0 (43714.)	1160.0 (40961.)	1138.0 (40184.)
HC SAMPLE METER/RANGE/PPM	11.7/21/ 5.87	13.5/21/ 6.77	17.9/21/ 8.93	14.0/21/ 6.98
HC BCKGRD METER/RANGE/PPM	6.2/ 1/ 3.10	6.6/ 1/ 3.30	7.1/ 1/ 3.55	7.5/ 1/ 3.75
CO SAMPLE METER/RANGE/PPM	7.3/13/ 6.51	6.0/13/ 5.34	10.0/13/ 8.95	6.8/13/ 6.06
CO BCKGRD METER/RANGE/PPM	.1/13/ .09	.1/13/ .09	.8/13/ .71	.8/13/ .71
CO2 SAMPLE METER/RANGE/PCT	54.7/13/.1088	63.7/13/.1286	68.9/12/.2858	53.3/13/.1057
CO2 BCKGRD METER/RANGE/PCT	21.1/13/.0388	21.1/13/.0388	12.6/12/.0429	21.3/13/.0392
NOX SAMPLE METER/RANGE/PPM	26.8/ 1/ 7.96	33.3/ 1/ 9.90	74.9/ 1/22.27	27.3/ 1/ 8.11
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .17	.7/ 1/ .20	1.7/ 1/ .50	1.2/ 1/ .35
DILUTION FACTOR	121.84	103.27	46.60	125.21
HC CONCENTRATION PPM	2.79	3.50	5.45	3.26
CO CONCENTRATION PPM	6.32	5.17	8.09	5.27
CO2 CONCENTRATION PCT	.0703	.0902	.2438	.0669
NOX CONCENTRATION PPM	7.80	9.70	21.79	7.77
HC MASS GRAMS	1.777	2.500	3.647	2.139
CO MASS GRAMS	8.119	7.450	10.925	6.984
CO2 MASS GRAMS	1420.15	2043.41	5178.66	1393.09
NOX MASS GRAMS	14.810	20.674	43.511	15.218
MASS OF FUEL BURNED GRAMS	454.29	651.50	1644.48	445.54
MEASURED DISTANCE KM (MILES)	.831 (.516)	1.837 (1.141)	5.324 (3.309)	.859 (.534)
FUEL ECONOMY L/100KM (MPG)	67.36 (3.492)	43.69 (5.385)	38.03 (6.185)	63.89 (3.682)
HC GRAMS/KM (GRAMS/MILE)	2.14 (3.44)	1.36 (2.19)	.68 (1.10)	2.49 (4.01)
CO GRAMS/KM (GRAMS/MILE)	9.78 (15.73)	4.06 (6.53)	2.05 (3.30)	8.13 (13.09)
CO2 GRAMS/KM (GRAMS/MILE)	1709.9 (2751.3)	1112.6 (1790.2)	972.6 (1564.9)	1622.2 (2610.2)
NOX GRAMS/KM (GRAMS/MILE)	17.83 (28.69)	11.26 (18.11)	8.17 (13.15)	17.72 (28.51)

H-TRAN COMPOSITE RESULTS

HC GRAMS/KM (GRAMS/MILE)	1.14 (1.83)
CO GRAMS/KM (GRAMS/MILE)	3.78 (6.09)
CO2 GRAMS/KM (GRAMS/MILE)	1133.89 (1824.44)
NOX GRAMS/KM (GRAMS/MILE)	10.65 (17.13)
TOTAL DISTANCE KM (MILES)	8.850 (5.50)
FUEL CONSUMPTION KG (LB)	3.196 (7.047)
FUEL ECONOMY L/100KM (MPG)	44.47 (5.29)

PARTICULATE RATE	
GRAMS/TEST	9.098
GRAMS/KG FUEL	2.85
GRAMS/KM	1.03
GRAMS/MILE	1.65

FILTER EFF. 92.39

TABLE D-17.H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 1	VEHICLE NO. 2126	TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04	DATE 12/ 5/84	ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
ENGINE 9.0 L(552. CID) V-6	BAG CART NO. 1	DIESEL EM-400-F
TRANSMISSION A-3	DYNO NO. 4	ODOMETER 155496. KM(96621. MILES)
GVW16738. KG(36900. LBS)	CVS NO. 11	
BAROMETER 747.78 MM HG(29.44 IN HG)	DRY BULB TEMP. 15.0 DEG C(59.0 DEG F)	NOX HUMIDITY CORRECTION FACTOR .90
RELATIVE HUMIDITY 43. PCT	ABS. HUMIDITY 4.6 GM/KG	

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	257.32 (9086.0)	257.28 (9084.7)	257.33 (9086.5)	257.27 (9084.1)
TOT. 20X20 RATE SCMM (SCFM)	3.31 (117.0)	3.31 (117.0)	3.31 (117.0)	3.31 (117.0)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.25)	.04 (1.25)	.04 (1.25)	.04 (1.25)
TOT FLOW STD. CU. METRES(SCF)	1103.5 (38964.)	1238.0 (43714.)	1160.0 (40961.)	1138.0 (40184.)
HC SAMPLE METER/RANGE/PPM	11.7/21/ 5.87	13.5/21/ 6.77	17.9/21/ 8.93	14.0/21/ 6.98
HC BCKGRD METER/RANGE/PPM	6.2/ 1/ 3.10	6.6/ 1/ 3.30	7.1/ 1/ 3.55	7.5/ 1/ 3.75
CO SAMPLE METER/RANGE/PPM	7.3/13/ 6.51	6.0/13/ 5.34	10.0/13/ 8.95	6.8/13/ 6.06
CO BCKGRD METER/RANGE/PPM	.1/13/ .09	.1/13/ .09	.8/13/ .71	.8/13/ .71
CO2 SAMPLE METER/RANGE/PCT	54.7/13/.1088	63.7/13/.1286	68.9/12/.2858	53.3/13/.1057
CO2 BCKGRD METER/RANGE/PCT	21.1/13/.0388	21.1/13/.0388	12.6/12/.0429	21.3/13/.0392
NOX SAMPLE METER/RANGE/PPM	9.1/12/ 9.07	11.5/12/11.47	24.6/12/24.65	9.3/12/ 9.34
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .17	.7/ 1/ .20	1.7/ 1/ .50	1.2/ 1/ .35
DILUTION FACTOR	121.84	103.27	46.60	125.21
HC CONCENTRATION PPM	2.79	3.50	5.45	3.26
CO CONCENTRATION PPM	6.32	5.17	8.09	5.27
CO2 CONCENTRATION PCT	.0703	.0902	.2438	.0669
NOX CONCENTRATION PPM	8.90	11.27	24.16	9.00
HC MASS GRAMS	1.777	2.500	3.647	2.139
CO MASS GRAMS	8.119	7.450	10.925	6.984
CO2 MASS GRAMS	1420.15	2043.41	5178.66	1393.09
NOX MASS GRAMS	16.911	24.022	48.250	17.627
MASS OF FUEL BURNED GRAMS	454.29	651.50	1644.48	445.54
MEASURED DISTANCE KM (MILES)	.831 (.516)	1.837 (1.141)	5.324 (3.309)	.859 (.534)
FUEL ECONOMY L/100KM (MPG)	67.36 (3.492)	43.69 (5.385)	38.03 (6.185)	63.89 (3.682)
HC GRAMS/KM (GRAMS/MILE)	2.14 (3.44)	1.36 (2.19)	.68 (1.10)	2.49 (4.01)
CO GRAMS/KM (GRAMS/MILE)	9.78 (15.73)	4.06 (6.53)	2.05 (3.30)	8.13 (13.09)
CO2 GRAMS/KM (GRAMS/MILE)	1709.9 (2751.3)	1112.6 (1790.2)	972.6 (1564.9)	1622.2 (2610.2)
NOX GRAMS/KM (GRAMS/MILE)	20.36 (32.76)	13.08 (21.05)	9.06 (14.58)	20.53 (33.03)

H-TRAN COMPOSITE RESULTS

	HC GRAMS/KM (GRAMS/MILE)	1.14 (1.83)
	CO GRAMS/KM (GRAMS/MILE)	3.78 (6.09)
	CO2 GRAMS/KM (GRAMS/MILE)	1133.89 (1824.44)
CONTINUOUS	NOX GRAMS/KM (GRAMS/MILE)	12.07 (19.42)
	TOTAL DISTANCE KM (MILES)	8.850 (5.50)
	FUEL CONSUMPTION KG (LB)	3.196 (7.047)
	FUEL ECONOMY L/100KM (MPG)	44.47 (5.29)

PARTICULATE RATE	
GRAMS/TEST	9.098
GRAMS/KG FUEL	2.85
GRAMS/KM	1.03
GRAMS/MILE	1.65
FILTER EFF.	92.39

TABLE D-18. H-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

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                                                                                  TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   2        RUN   1                 VEHICLE NO. 2126                      ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04             DATE    12/ 6/84                      DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                BAG CART NO.  1                       ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                            DYNO NO.      4
GVW16738. KG(36900. LBS)                    CVS NO.      11

BAROMETER 760.48 MM HG(29.94 IN HG)         DRY BULB TEMP. 12.8 DEG C(55.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  39. PCT                  ABS. HUMIDITY  3.5 GM/KG
BAG RESULTS
  BAG NUMBER                                      1                 2                 3                 4
  DESCRIPTION                                   NYNF              LANF               LAF              NYNF

  RUN TIME                  SECONDS             254.0             285.0             267.0             262.0
  TOT. BLOWER RATE SCMM (SCFM)         262.51 ( 9269.3)  262.48 ( 9268.3)  262.54 ( 9270.2)  262.47 ( 9267.8)
  TOT. 20X20 RATE SCMM (SCFM)              3.38 (119.4)      3.38 (119.4)      3.38 (119.4)      3.38 (119.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)         .04 ( 1.28)       .04 ( 1.28)       .04 ( 1.28)       .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)       1125.8 ( 39751.)  1263.0 ( 44598.)  1183.5 ( 41790.)  1161.0 ( 40996.)

  HC  SAMPLE METER/RANGE/PPM             13.0/21/ 6.52     15.3/21/ 7.65     19.7/21/ 9.87     14.8/21/ 7.42
  HC  BCKGRD METER/RANGE/PPM              6.0/ 1/ 3.00      7.3/ 1/ 3.65      8.7/ 1/ 4.35     10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM              6.0/13/ 5.34      5.2/13/ 4.63      9.4/13/ 8.40      5.0/13/ 4.45
  CO  BCKGRD METER/RANGE/PPM               .1/13/  .09       .1/13/  .09       .4/13/  .35       .7/13/  .62
  CO2 SAMPLE METER/RANGE/PCT             54.1/13/.1075     63.7/13/.1286     67.9/12/.2807     52.8/13/.1046
  CO2 BCKGRD METER/RANGE/PCT             20.6/13/.0378     21.2/13/.0390     12.9/12/.0439     21.6/13/.0398
  NOX SAMPLE METER/RANGE/PPM             28.2/ 1/ 8.38     34.9/ 1/10.37     80.7/ 1/24.00     29.5/ 1/ 8.77
  NOX BCKGRD METER/RANGE/PPM               .9/ 1/  .26      1.3/ 1/  .38      2.8/ 1/  .83      2.2/ 1/  .65
  DILUTION FACTOR                           123.35            103.25             47.44            126.62

  HC  CONCENTRATION PPM                       3.54              4.04              5.61              2.46
  CO  CONCENTRATION PPM                       5.18              4.47              7.91              3.78
  CO2 CONCENTRATION PCT                      .0700             .0900             .2377             .0652
  NOX CONCENTRATION PPM                       8.12             10.00             23.19              8.13
  HC  MASS GRAMS                             2.301             2.942             3.829             1.646
  CO  MASS GRAMS                             6.787             6.574            10.901             5.104
  CO2 MASS GRAMS                           1442.07           2080.21           5149.78           1385.73
  NOX MASS GRAMS                            15.463            21.354            46.408            15.953
  MASS OF FUEL BURNED GRAMS                 461.07            663.13           1635.53            441.79
  MEASURED DISTANCE  KM (MILES)         .857 ( .532)    1.785 (1.109)     5.402 (3.357)      .861 ( .535)
  FUEL ECONOMY  L/100KM (MPG)         66.28 ( 3.549)    45.75 ( 5.142)    37.29 ( 6.309)    63.20 ( 3.722)

  HC   GRAMS/KM (GRAMS/MILE)           2.69 (  4.32)     1.65 (  2.65)      .71 (  1.14)     1.91 (  3.08)
  CO   GRAMS/KM (GRAMS/MILE)           7.92 ( 12.75)     3.68 (  5.93)     2.02 (  3.25)     5.93 (  9.54)
  CO2  GRAMS/KM (GRAMS/MILE)         1683.3 (2708.5)   1165.4 (1875.2)    953.4 (1534.0)   1609.8 (2590.2)
  NOX  GRAMS/KM (GRAMS/MILE)          18.05 ( 29.04)    11.96 ( 19.25)     8.59 ( 13.82)    18.53 ( 29.82)

                                    H-TRAN COMPOSITE RESULTS                         PARTICULATE RATE
              HC   GRAMS/KM (GRAMS/MILE)     1.20 ( 1.94)                            GRAMS/TEST       8.049
              CO   GRAMS/KM (GRAMS/MILE)     3.30 (  5.31)                           GRAMS/KG FUEL    2.51
              CO2  GRAMS/KM (GRAMS/MILE)  1129.58 (1817.50)                          GRAMS/KM          .90
              NOX  GRAMS/KM (GRAMS/MILE)    11.14 (17.92)                            GRAMS/MILE       1.45

              TOTAL DISTANCE  KM (MILES)     8.904 ( 5.53)                           FILTER EFF.     91.56
              FUEL CONSUMPTION  KG (LB)      3.202 ( 7.059)
              FUEL ECONOMY  L/100KM (MPG)   44.28 ( 5.31)
```

TABLE D-18. H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)

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                                        PROJECT 03-5428-001

TEST NO.   2        RUN   1           VEHICLE NO. 2126              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04       DATE   12/ 6/84                  UAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6          BAG CART NO.  1               DIESEL    EM-400-F
TRANSMISSION A-3                      DYNO NO.      4               ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)              CVS NO.      11

BAROMETER 760.48 MM HG(29.94 IN HG)   DRY BULB TEMP. 12.8 DEG C(55.0 DEG F)
RELATIVE HUMIDITY  39. PCT            ABS. HUMIDITY  3.5 GM/KG      NOX HUMIDITY CORRECTION FACTOR   .88
BAG RESULTS
  BAG NUMBER                                 1               2               3               4
  DESCRIPTION                              NYNF            LANF             LAF            NYNF

  RUN TIME                 SECONDS         254.0           285.0           267.0           262.0
  TOT. BLOWER RATE SCMM (SCFM)       262.51 ( 9269.3) 262.48 ( 9268.3) 262.54 ( 9270.2) 262.47 ( 9267.8)
  TOT. 20X20 RATE SCMM (SCFM)          3.38 (119.4)     3.38 (119.4)     3.38 (119.4)     3.38 (119.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)     .04 ( 1.28)      .04 ( 1.28)      .04 ( 1.28)      .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)     1125.8 ( 39751.) 1263.0 ( 44598.) 1183.5 ( 41790.) 1161.0 ( 40996.)

  HC  SAMPLE METER/RANGE/PPM          13.0/21/ 6.52    15.3/21/ 7.65    19.7/21/ 9.87    14.8/21/ 7.42
  HC  BCKGRD METER/RANGE/PPM           6.0/ 1/ 3.00     7.3/ 1/ 3.65     8.7/ 1/ 4.35    10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM           6.0/13/ 5.34     5.2/13/ 4.63     9.4/13/ 8.40     5.0/13/ 4.45
  CO  BCKGRD METER/RANGE/PPM            .1/13/  .09      .1/13/  .09      .4/13/  .35      .7/13/  .62
  CO2 SAMPLE METER/RANGE/PCT          54.1/13/.1075    63.7/13/.1286    67.9/12/.2807    52.8/13/.1046
  CO2 BCKGRD METER/RANGE/PCT          20.6/13/.0378    21.2/13/.0390    12.9/12/.0439    21.6/13/.0398
  NOX SAMPLE METER/RANGE/PPM           9.0/12/ 8.96    11.6/12/11.57    24.2/12/24.22     9.4/12/ 9.40
  NOX BCKGRD METER/RANGE/PPM            .9/ 1/  .26     1.3/ 1/  .38     2.8/ 1/  .83     2.2/ 1/  .65
  DILUTION FACTOR                      123.35           103.25            47.44           126.62

  HC  CONCENTRATION PPM                  3.54             4.04             5.61             2.46
  CO  CONCENTRATION PPM                  5.18             4.47             7.91             3.78
  CO2 CONCENTRATION PCT                  .0700            .0900            .2377            .0652
  NOX CONCENTRATION PPM                  8.70            11.20            23.41             8.76
  HC  MASS GRAMS                         2.301            2.942            3.829            1.646
  CO  MASS GRAMS                         6.787            6.574           10.901            5.104
  CO2 MASS GRAMS                      1442.07          2080.21          5149.78          1385.73
  NOX MASS GRAMS                        16.559           23.908           46.840           17.190
  MASS OF FUEL BURNED GRAMS            461.07           663.13          1635.53           441.79
  MEASURED DISTANCE  KM (MILES)       .857 ( .532)    1.785 (1.109)    5.402 (3.357)     .861 ( .535)
  FUEL ECONOMY  L/100KM (MPG)        66.28 ( 3.549)   45.75 ( 5.142)   37.29 ( 6.309)   63.20 ( 3.722)

  HC   GRAMS/KM (GRAMS/MILE)          2.69 (  4.32)    1.65 (  2.65)     .71 (  1.14)    1.91 (  3.08)
  CO   GRAMS/KM (GRAMS/MILE)          7.92 ( 12.75)    3.68 (  5.93)    2.02 (  3.25)    5.93 (  9.54)
  CO2  GRAMS/KM (GRAMS/MILE)        1683.3 (2708.5)  1165.4 (1875.2)   953.4 (1534.0)  1609.8 (2590.2)
  NOX  GRAMS/KM (GRAMS/MILE)         19.33 ( 31.10)   13.39 ( 21.55)    8.67 ( 13.95)   19.97 ( 32.13)

                                  H-TRAN COMPOSITE RESULTS
                   HC   GRAMS/KM (GRAMS/MILE)     1.20 ( 1.94)           PARTICULATE RATE
                   CO   GRAMS/KM (GRAMS/MILE)     3.30 (  5.31)          GRAMS/TEST         8.049
                   CO2  GRAMS/KM (GRAMS/MILE)  1129.58 (1817.50)         GRAMS/KG FUEL      2.51
      CONTINUOUS   NOX  GRAMS/KM (GRAMS/MILE)    11.74 (18.88)           GRAMS/KM            .90
                                                                         GRAMS/MILE         1.45

                   TOTAL DISTANCE  KM (MILES)     8.904 ( 5.53)          FILTER EFF.     91.56
                   FUEL CONSUMPTION  KG (LB)      3.202 ( 7.059)
                   FUEL ECONOMY  L/100KM (MPG)   44.28 ( 5.31)
```

TABLE D-19. BUS F VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   1        RUN   1              VEHICLE NO. 2126             TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04          DATE   12/ 5/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6             BAG CART NO.  1              DIESEL    EM-400-F
TRANSMISSION A-3                         DYNO NO.      4              ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                 CVS NO.      11

BAROMETER 748.03 MM HG(29.45 IN HG)      DRY BULB TEMP. 14.4 DEG C(58.0 DEG F)
RELATIVE HUMIDITY  47. PCT               ABS. HUMIDITY  4.9 GM/KG     NOX HUMIDITY CORRECTION FACTOR   .90

BAG RESULTS
  TEST CYCLE                                  BUS F

  RUN TIME                SECONDS             1194.4
  TOT. BLOWER RATE SCMM (SCFM)             173.28 ( 6118.4)
  TOT. 20X20 RATE SCMM (SCFM)                3.31 (116.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)           .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)            3516.0 (124150.)

  HC  SAMPLE METER/RANGE/PPM                16.6/21/ 8.29
  HC  BCKGRD METER/RANGE/PPM                 7.7/ 1/ 3.85
  CO  SAMPLE METER/RANGE/PPM                 5.1/13/ 4.54
  CO  BCKGRD METER/RANGE/PPM                  .7/13/  .62
  CO2 SAMPLE METER/RANGE/PCT                63.0/13/.1270
  CO2 BCKGRD METER/RANGE/PCT                21.2/13/.0390
  NOX SAMPLE METER/RANGE/PPM                38.3/ 1/11.39
  NOX BCKGRD METER/RANGE/PPM                  .8/ 1/  .23
  DILUTION FACTOR                             104.47

  H    ONCENTRATION PPM                        4.48
  CO  CONCENTRATION PPM                        3.85
  CO2 CONCENTRATION PCT                       .0884
  NOX CONCENTRATION PPM                       11.16
  HC  MASS GRAMS                               9.074
  CO  MASS GRAMS                              15.770
  CO2 MASS GRAMS                            5689.90
  NOX MASS GRAMS                              67.798
  MASS OF FUEL BURNED GRAMS                 1813.76
  MEASURED DISTANCE  KM (MILES)             4.561 (2.834)
  FUEL ECONOMY  L/100KM (MPG)               48.97 ( 4.803)

  HC    GRAMS/KM (GRAMS/MILE)                1.99 (   3.20)
  CO    GRAMS/KM (GRAMS/MILE)                3.46 (   5.56)
  CO2   GRAMS/KM (GRAMS/MILE)              1247.6 (2007.4)
  NOX   GRAMS/KM (GRAMS/MILE)               14.87 ( 23.92)

                                              BUS F  COMPOSITE RESULTS
                  HC   GRAMS/KM (GRAMS/MILE)     1.99 ( 3.20)          PARTICULATE RATE
                  CO   GRAMS/KM (GRAMS/MILE)     3.46 (  5.56)         GRAMS/TEST       4.168
                  CO2  GRAMS/KM (GRAMS/MILE)  1247.59 (2007.37)        GRAMS/KG FUEL    2.30
                  NOX  GRAMS/KM (GRAMS/MILE)    14.87 (23.92)          GRAMS/KM          .91
                                                                       GRAMS/MILE       1.47

                  TOTAL DISTANCE  KM (MILES)     4.561 ( 2.83)
                  FUEL CONSUMPTION  KG (LB)      1.814 ( 3.999)        FILTER EFF.     82.30
                  FUEL ECONOMY  L/100KM (MPG)    48.97 ( 4.80)
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TABLE D-19. BUS F VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

```
                                                   VEHICLE NO. 2126                  TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   1          RUN   1                      DATE   12/ 5/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                    BAG CART NO.  1                   DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                       DYNO NO.      4                   ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                                   CVS NO.      11
GVW16738. KG(36900. LBS)

BAROMETER 748.03 MM HG(29.45 IN HG)                DRY BULB TEMP. 14.4 DEG C(58.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR    .90
RELATIVE HUMIDITY  47. PCT                         ABS. HUMIDITY  4.9 GM/KG

BAG RESULTS                                           BUS F
   TEST CYCLE
                                                     1194.4
   RUN TIME                  SECONDS             173.28 ( 6118.4)
   TOT. BLOWER RATE SCMM (SCFM)                    3.31 (116.9)
   TOT. 20X20 RATE SCMM (SCFM)                      .04 ( 1.28)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)            3516.0 (124150.)
   TOT FLOW STD. CU. METRES(SCF)

                                                  16.6/21/ 8.29
   HC  SAMPLE METER/RANGE/PPM                      7.7/ 1/ 3.85
   HC  BCKGRD METER/RANGE/PPM                      5.1/13/ 4.54
   CO  SAMPLE METER/RANGE/PPM                       .7/13/  .62
   CO  BCKGRD METER/RANGE/PPM                     63.0/13/.1270
   CO2 SAMPLE METER/RANGE/PCT                     21.2/13/.0390
   CO2 BCKGRD METER/RANGE/PCT                     11.9/12/11.94
   NOX SAMPLE METER/RANGE/PPM                       .8/ 1/  .23
   NOX BCKGRD METER/RANGE/PPM                      104.47
   DILUTION FACTOR
                                                    4.48
   HC  CONCENTRATION PPM                            3.85
   CO  CONCENTRATION PPM                           .0884
   CO2 CONCENTRATION PCT                           11.71
   NOX CONCENTRATION PPM                            9.074
   HC  MASS GRAMS                                  15.770
   CO  MASS GRAMS                                5689.90
   CO2 MASS GRAMS                                  71.138
   NOX MASS GRAMS                                1813.76
   MASS OF FUEL BURNED GRAMS                     4.561 (2.834)
   MEASURED DISTANCE  KM (MILES)                48.97 ( 4.803)
   FUEL ECONOMY  L/100KM (MPG)
                                                  1.99 (  3.20)
   HC   GRAMS/KM (GRAMS/MILE)                     3.46 (  5.56)
   CO   GRAMS/KM (GRAMS/MILE)                  1247.6 (2007.4)
   CO2  GRAMS/KM (GRAMS/MILE)                    15.60 ( 25.10)
   NOX  GRAMS/KM (GRAMS/MILE)

                                            BUS F  COMPOSITE RESULTS
                                                                                  PARTICULATE RATE
                     HC   GRAMS/KM (GRAMS/MILE)    1.99 ( 3.20)                   GRAMS/TEST       4.168
                     CO   GRAMS/KM (GRAMS/MILE)    3.46 (  5.56)                  GRAMS/KG FUEL    2.30
                     CO2  GRAMS/KM (GRAMS/MILE) 1247.59 (2007.37)                 GRAMS/KM          .91
         CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)   15.60 (25.10)                   GRAMS/MILE       1.47


                     TOTAL DISTANCE  KM (MILES)      4.561 ( 2.83)                FILTER EFF.     82.30
                     FUEL CONSUMPTION  KG (LB)       1.814 ( 3.999)
                     FUEL ECONOMY  L/100KM (MPG)    48.97 ( 4.80)
```

TABLE D-20. BUS F VEHICLE EMISSIONS RESULTS

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                                           PROJECT 03-5428-001

TEST NO.    2        RUN    1                VEHICLE NO. 2126                TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE    12/ 6/84                ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                 DIESEL     EM-400-F
TRANSMISSION A-3                             DYNO NO.      4                 ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.      11

BAROMETER 760.48 MM HG(29.94 IN HG)          DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)
RELATIVE HUMIDITY  30. PCT                   ABS. HUMIDITY  3.3 GM/KG        NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
  TEST CYCLE                                        BUS F

  RUN TIME                 SECONDS                 1188.3
  TOT. BLOWER RATE SCMM (SCFM)                  177.18 ( 6256.1)
  TOT. 20X20 RATE SCMM (SCFM)                     3.38 (119.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                .04 ( 1.28)
  TOT FLOW STD. CU. METRES(SCF)                 3576.7 (126292.)

  HC   SAMPLE METER/RANGE/PPM                    16.9/21/ 8.44
  HC   BCKGRD METER/RANGE/PPM                     8.5/ 1/ 4.25
  CO   SAMPLE METER/RANGE/PPM                     4.0/13/ 3.55
  CO   BCKGRD METER/RANGE/PPM                      .4/13/  .35
  CO2  SAMPLE METER/RANGE/PCT                    63.0/13/.1270
  CO2  BCKGRD METER/RANGE/PCT                    21.4/13/.0394
  NOX  SAMPLE METER/RANGE/PPM                    39.2/ 1/11.65
  NOX  BCKGRD METER/RANGE/PPM                      .8/ 1/  .23
  DILUTION FACTOR                                  104.53

  HC   CONCENTRATION PPM                            4.23
  CO   CONCENTRATION PPM                            3.16
  CO2  CONCENTRATION PCT                           .0880
  NOX  CONCENTRATION PPM                           11.43
  HC   MASS GRAMS                                   8.726
  CO   MASS GRAMS                                  13.172
  CO2  MASS GRAMS                                5762.43
  NOX  MASS GRAMS                                  68.854
  MASS OF FUEL BURNED GRAMS                      1835.02
  MEASURED DISTANCE  KM (MILES)                  4.615 (2.868)
  FUEL ECONOMY   L/100KM (MPG)                   48.96 ( 4.804)

  HC    GRAMS/KM (GRAMS/MILE)                     1.89 (   3.04)
  CO    GRAMS/KM (GRAMS/MILE)                     2.85 (   4.59)
  CO2   GRAMS/KM (GRAMS/MILE)                   1248.6 (2009.0)
  NOX   GRAMS/KM (GRAMS/MILE)                    14.92 ( 24.01)

                                           BUS F  COMPOSITE RESULTS
               HC    GRAMS/KM (GRAMS/MILE)      1.89 ( 3.04)             PARTICULATE RATE
               CO    GRAMS/KM (GRAMS/MILE)      2.85 (  4.59)            GRAMS/TEST        3.720
               CO2   GRAMS/KM (GRAMS/MILE)   1248.61 (2009.02)           GRAMS/KG FUEL     2.03
               NOX   GRAMS/KM (GRAMS/MILE)     14.92 (24.01)             GRAMS/KM           .81
                                                                         GRAMS/MILE        1.30

               TOTAL DISTANCE  KM (MILES)      4.615 ( 2.87)
               FUEL CONSUMPTION  KG (LB)       1.835 ( 4.046)            FILTER EFF.     93.56
               FUEL ECONOMY  L/100KM (MPG)     48.96 ( 4.80)
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TABLE D-20. BUS F VEHICLE EMISSIONS RESULTS (Cont'd)

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                                        PROJECT 03-5428-001

                                                                   TEST WEIGHT 13608. KG(30000. LBS)
                                   VEHICLE NO. 2126                ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
TEST NO.   2         RUN   1         TE   12/ 6/84                 DIESEL     EM-400-F
VEHICLE MODEL 1983 GMC RTSII 04    BAG CART NO.  1                 ODOMETER 155496. KM( 96621. MILES)
ENGINE  9.0 L( 552. CID) V-6       DYNO NO.      4
TRANSMISSION A-3                   CVS NO.      11
GVW16738. KG(36900. LBS)
                                   DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR   .88
BAROMETER 760.48 MM HG(29.94 IN HG)   ABS. HUMIDITY  3.3 GM/KG
RELATIVE HUMIDITY  30. PCT

BAG RESULTS                              BUS F
  TEST CYCLE
                                        1188.3
  RUN TIME                SECUNDS    177.18 ( 6256.1)
  TOT. BLOWER RATE SCMM (SCFM)         3.38 (119.4)
  TOT. 20X20 RATE SCMM (SCFM)           .04 ( 1.28)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)  3576.7 (126292.)
  TOT FLOW STD. CU. METRES(SCF)
                                      16.9/21/ 8.44
  HC  SAMPLE METER/RANGE/PPM           8.5/ 1/ 4.25
  HC  BCKGRD METER/RANGE/PPM           4.0/13/ 3.55
  CO  SAMPLE METER/RANGE/PPM            .4/13/  .35
  CO  BCKGRD METER/RANGE/PPM          63.0/13/.1270
  CO2 SAMPLE METER/RANGE/PCT          21.4/13/.0394
  CO2 BCKGRD METER/RANGE/PCT          12.0/12/12.00
  NOX SAMPLE METER/RANGE/PPM            .8/ 1/  .23
  NOX BCKGRD METER/RANGE/PPM            104.53
  DILUTION FACTOR
                                          4.23
  HC  CONCENTRATION PPM                   3.16
  CO  CONCENTRATION PPM                  .0880
  CO2 CONCENTRATION PCT                  11.77
  NOX CONCENTRATION PPM                  8.726
  HC  MASS GRAMS                        13.172
  CO  MASS GRAMS                       5762.43
  CO2 MASS GRAMS                        70.922
  NOX MASS GRAMS                       1835.02
  MASS OF FUEL BURNED GRAMS          4.615 (2.868)
  MEASURED DISTANCE  KM (MILES)      48.96 ( 4.804)
  FUEL ECONOMY  L/100KM (MPG)
                                        1.89 (  3.04)
  HC   GRAMS/KM (GRAMS/MILE)            2.85 (  4.59)
  CO   GRAMS/KM (GRAMS/MILE)          1248.6 (2009.0)
  CO2  GRAMS/KM (GRAMS/MILE)           15.37 ( 24.73)
  NOX  GRAMS/KM (GRAMS/MILE)

                                        BUS F  COMPOSITE RESULTS         PARTICULATE RATE
                HC   GRAMS/KM (GRAMS/MILE)     1.89 ( 3.04)              GRAMS/TEST       3.720
                CO   GRAMS/KM (GRAMS/MILE)     2.85 (  4.59)             GRAMS/KG FUEL    2.03
                CO2  GRAMS/KM (GRAMS/MILE)  1248.61 (2009.02)            GRAMS/KM          .81
     CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)    15.37 (24.73)              GRAMS/MILE       1.30


       TOTAL DISTANCE  KM (MILES)     4.615 ( 2.87)                      FILTER EFF.     93.56
       FUEL CONSUMPTION  KG (LB)      1.835 ( 4.046)
       FUEL ECONOMY  L/100KM (MPG)    48.96 ( 4.80)
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                         TABLE D-21.    BUS UN VEHICLE EMISSIONS RESULTS
                                               PROJECT 03-5428-001

                                                        VEHICLE NO. 2126              TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   1         RUN   1                            DATE    12/ 5/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                         BAG CART NO.  1               DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                            DYNO NO.      4                DOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                                        CVS NO.      11
GVW16738. KG(36900. LBS)

BAROMETER 747.52 MM HG(29.43 IN HG)                     DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR   .90
RELATIVE HUMIDITY  44. PCT                              ABS. HUMIDITY  4.9 GM/KG

BAG RESULTS
   TEST CYCLE                                                BUS UN

   RUN TIME                  SECONDS                         1188.7
   TOT. BLOWER RATE SCMM (SCFM)                         172.34 ( 6085.5)
   TOT. 20X20 RATE SCMM (SCFM)                            3.30 (116.5)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)                       .03 (   .95)
   TOT FLOW STD. CU. METRES(SCF)                        3480.3 (122890.)

   HC   SAMPLE METER/RANGE/PPM                            16.9/21/ 8.46
   HC   BCKGRD METER/RANGE/PPM                             7.8/ 1/ 3.90
   CO   SAMPLE METER/RANGE/PPM                             9.6/13/ 8.58
   CO   BCKGRD METER/RANGE/PPM                              .8/13/   .71
   CO2  SAMPLE METER/RANGE/PCT                            68.4/13/.1392
   CO2  BCKGRD METER/RANGE/PCT                            20.9/13/.0384
   NOX  SAMPLE METER/RANGE/PPM                            40.6/ 1/12.07
   NOX  BCKGRD METER/RANGE/PPM                              .7/ 1/   .20
   DILUTION FACTOR                                             95.12

   HC   CONCENTRATION PPM                                       4.60
   CO   CONCENTRATION PPM                                       7.75
   CO2  CONCENTRATION PCT                                      .1012
   NOX  CONCENTRATION PPM                                      11.87
   HC   MASS GRAMS                                             9.225
   CO   MASS GRAMS                                            31.397
   CO2  MASS GRAMS                                           6448.80
   NOX  MASS GRAMS                                            71.458
   MASS OF FUEL BURNED GRAMS                                 2061.32
   MEASURED DISTANCE  KM (MILES)                         4.610 (2.865)
   FUEL ECONOMY   L/100KM (MPG)                          55.06 ( 4.272)

   HC    GRAMS/KM (GRAMS/MILE)                            2.00 (   3.22)
   CO    GRAMS/KM (GRAMS/MILE)                            6.81 (  10.96)
   CO2   GRAMS/KM (GRAMS/MILE)                          1398.8 (2250.7)
   NOX   GRAMS/KM (GRAMS/MILE)                           15.50 (  24.94)

                                                        BUS UN COMPOSITE RESULTS
                                                                                        PARTICULATE RATE
                     HC    GRAMS/KM (GRAMS/MILE)         2.00 (  3.22)                  GRAMS/TEST        6.636
                     CO    GRAMS/KM (GRAMS/MILE)         6.81 ( 10.96)                  GRAMS/KG FUEL     3.22
                     CO2   GRAMS/KM (GRAMS/MILE)      1398.80 (2250.66)                 GRAMS/KM          1.44
                     NOX   GRAMS/KM (GRAMS/MILE)        15.50 (24.94)                    RAMS/MILE        2.32


                     TOTAL DISTANCE  KM (MILES)         4.610 (  2.87)                  FILTER EFF.      92.12
                     FUEL CONSUMPTION  KG (LB)          2.061 (  4.545)
                     FUEL ECONOMY   L/100KM (MPG)       55.06 (  4.27)
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TABLE D-21. BUS UN VEHICLE EMISSIONS RESULTS (Cont'd)

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                                    PROJECT 03-5428-001

TEST NO.   1         RUN   1                VEHICLE NO. 2126                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04             DATE   12/ 5/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                BAG CART NO.  1                   DIESEL     EM-400-F
TRANSMISSION A-3                            DYNO NO.      4                   ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                    CVS NO.      11

BAROMETER 747.52 MM HG(29.43 IN HG)         DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR   .90
RELATIVE HUMIDITY  44. PCT                  ABS. HUMIDITY  4.9 GM/KG

BAG RESULTS
  TEST CYCLE                                  BUS UN

  RUN TIME               SECONDS              1188.7
  TOT. BLOWER RATE SCMM (SCFM)             172.34 ( 6085.5)
  TOT. 20X20 RATE SCMM (SCFM)                3.30 (116.5)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)           .03 (   .95)
  TOT FLOW STD. CU. METRES(SCF)            3480.3 (122890.)

  HC  SAMPLE METER/RANGE/PPM                16.9/21/ 8.46
  HC  BCKGRD METER/RANGE/PPM                 7.8/ 1/ 3.90
  CO  SAMPLE METER/RANGE/PPM                 9.6/13/ 8.58
  CO  BCKGRD METER/RANGE/PPM                  .8/13/  .71
  CO2 SAMPLE METER/RANGE/PCT                68.4/13/.1392
  CO2 BCKGRD METER/RANGE/PCT                20.9/13/.0384
  NOX SAMPLE METER/RANGE/PPM                12.6/12/12.57
  NOX BCKGRD METER/RANGE/PPM                 .7/ 1/  .20
  DILUTION FACTOR                              95.12

  HC  CONCENTRATION PPM                        4.60
  CO  CONCENTRATION PPM                        7.75
  CO2 CONCENTRATION PCT                        .1012
  NOX CONCENTRATION PPM                       12.38
  HC  MASS GRAMS                               9.225
  CO  MASS GRAMS                              31.397
  CO2 MASS GRAMS                            6448.80
  NOX MASS GRAMS                              74.492
  MASS OF FUEL BURNED GRAMS                 2061.32
  MEASURED DISTANCE  KM (MILES)             4.610 (2.865)
  FUEL ECONOMY  L/100KM (MPG)              55.06 ( 4.272)

  HC   GRAMS/KM (GRAMS/MILE)                2.00 (   3.22)
  CO   GRAMS/KM (GRAMS/MILE)                6.81 (  10.96)
  CO2  GRAMS/KM (GRAMS/MILE)              1398.8 (2250.7)
  NOX  GRAMS/KM (GRAMS/MILE)               16.16 (  26.00)

                                              BUS UN COMPOSITE RESULTS
                     HC   GRAMS/KM (GRAMS/MILE)     2.00 ( 3.22)            PARTICULATE RATE
                     CO   GRAMS/KM (GRAMS/MILE)     6.81 ( 10.96)           GRAMS/TEST        6.636
                     CO2  GRAMS/KM (GRAMS/MILE)  1398.80 (2250.66)          GRAMS/KG FUEL     3.22
         CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)    16.16 (26.00)            GRAMS/KM          1.44
                                                                            GRAMS/MILE        2.32

                     TOTAL DISTANCE  KM (MILES)     4.610 ( 2.87)           FILTER EFF.     92.12
                     FUEL CONSUMPTION  KG (LB)      2.061 ( 4.545)
                     FUEL ECONOMY  L/100KM (MPG)    55.06 ( 4.27)
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                         TABLE D-22.BUS UN VEHICLE EMISSIONS RESULTS
                                   PROJECT 03-5428-001

                                                                         TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   2       RUN   1                  VEHICLE NO. 2126             ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04             DATE   12/ 6/84              DIESEL    EM-400-F
ENGINE  9.0 L( 552. CID) V-6                BAG CART NO.  1              ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                            DYNO NO.      4
GVW16738. KG(36900. LBS)                    CVS NO.      11

BAROMETER 760.48 MM HG(29.94 IN HG)         DRY BULB TEMP. 16.1 DEG C(61.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  27. PCT                  ABS. HUMIDITY  3.1 GM/KG

BAG RESULTS                                        BUS UN
  TEST CYCLE

  RUN TIME                 SECONDS                 1189.2
  TOT. BLOWER RATE SCMM (SCFM)                   176.44 ( 6230.3)
  TOT. 20X20 RATE SCMM (SCFM)                      3.35 (118.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                 .03 (  .96)
  TOT FLOW STD. CU. METRES(SCF)                  3564.2 (125850.)

  HC  SAMPLE METER/RANGE/PPM                       15.4/21/ 7.70
  HC  BCKGRD METER/RANGE/PPM                        8.3/ 1/ 4.15
  CO  SAMPLE METER/RANGE/PPM                        8.1/13/ 7.23
  CO  BCKGRD METER/RANGE/PPM                         .3/13/  .27
  CO2 SAMPLE METER/RANGE/PCT                       69.1/13/.1408
  CO2 BCKGRD METER/RANGE/PCT                       21.1/13/.0388
  NOX SAMPLE METER/RANGE/PPM                       42.9/ 1/12.75
  NOX BCKGRD METER/RANGE/PPM                         .9/ 1/  .26
  DILUTION FACTOR                                     94.18

  HC  CONCENTRATION PPM                                3.60
  CO  CONCENTRATION PPM                                6.89
  CO2 CONCENTRATION PCT                                .1024
  NOX CONCENTRATION PPM                               12.50
  HC  MASS GRAMS                                       7.389
  CO  MASS GRAMS                                      28.579
  CO2 MASS GRAMS                                    6683.69
  NOX MASS GRAMS                                      74.769
  MASS OF FUEL BURNED GRAMS                         2132.27
  MEASURED DISTANCE  KM (MILES)                    4.729 (2.939)
  FUEL ECONOMY  L/100KM (MPG)                      55.52 ( 4.237)

  HC   GRAMS/KM (GRAMS/MILE)                        1.56 (  2.51)
  CO   GRAMS/KM (GRAMS/MILE)                        6.04 (  9.72)
  CO2  GRAMS/KM (GRAMS/MILE)                      1413.3 (2273.9)
  NOX  GRAMS/KM (GRAMS/MILE)                       15.81 ( 25.44)

                                           BUS UN COMPOSITE RESULTS          PARTICULATE RATE
                 HC   GRAMS/KM (GRAMS/MILE)      1.56 ( 2.51)                GRAMS/TEST      5.639
                 CO   GRAMS/KM (GRAMS/MILE)      6.04 (  9.72)               GRAMS/KG FUEL   2.64
                 CO2  GRAMS/KM (GRAMS/MILE)   1413.25 (2273.93)              GRAMS/KM        1.19
                 NOX  GRAMS/KM (GRAMS/MILE)     15.81 (25.44)                GRAMS/MILE      1.92


                 TOTAL DISTANCE  KM (MILES)     4.729 ( 2.94)                FILTER EFF.     96.27
                 FUEL CONSUMPTION  KG (LB)      2.132 ( 4.702)
                 FUEL ECONOMY  L/100KM (MPG)    55.52 ( 4.24)
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TABLE D-22. BUS UN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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TEST NO.   2        RUN   1          VEHICLE NO. 2126                   TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04      DATE   12/ 6/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6         BAG CART NO.  1                    DIESEL    EM-400-F
TRANSMISSION A-3                     DYNO NO.      4                    ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)             CVS NO.      11

BAROMETER 760.48 MM HG(29.94 IN HG)  DRY BULB TEMP. 16.1 DEG C(61.0 DEG F)  NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  27. PCT           ABS. HUMIDITY  3.1 GM/KG

BAG RESULTS
  TEST CYCLE                               BUS UN

  RUN TIME              SECONDS            1189.2
  TOT. BLOWER RATE SCMM (SCFM)          176.44 ( 6230.3)
  TOT. 20X20 RATE SCMM (SCFM)             3.35 (118.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)        .03 (  .96)
  TOT FLOW STD. CU. METRES(SCF)         3564.2 (125850.)

  HC  SAMPLE METER/RANGE/PPM             15.4/21/ 7.70
  HC  BCKGRD METER/RANGE/PPM              8.3/ 1/ 4.15
  CO  SAMPLE METER/RANGE/PPM              8.1/13/ 7.23
  CO  BCKGRD METER/RANGE/PPM               .3/13/  .27
  CO2 SAMPLE METER/RANGE/PCT             69.1/13/.1408
  CO2 BCKGRD METER/RANGE/PCT             21.1/13/.0388
  NOX SAMPLE METER/RANGE/PPM             13.7/12/13.68
  NOX BCKGRD METER/RANGE/PPM               .9/ 1/  .26
  DILUTION FACTOR                           94.18

  HC  CONCENTRATION PPM                      3.60
  CO  CONCENTRATION PPM                      6.89
  CO2 CONCENTRATION PCT                     .1024
  NOX CONCENTRATION PPM                     13.43
  HC  MASS GRAMS                             7.389
  CO  MASS GRAMS                            28.579
  CO2 MASS GRAMS                          6683.69
  NOX MASS GRAMS                            80.325
  MASS OF FUEL BURNED GRAMS               2132.27
  MEASURED DISTANCE  KM (MILES)          4.729 (2.939)
  FUEL ECONOMY  L/100KM (MPG)            55.52 ( 4.237)

  HC   GRAMS/KM (GRAMS/MILE)              1.56 (  2.51)
  CO   GRAMS/KM (GRAMS/MILE)              6.04 (  9.72)
  CO2  GRAMS/KM (GRAMS/MILE)            1413.3 (2273.9)
  NOX  GRAMS/KM (GRAMS/MILE)             16.98 ( 27.33)

                                          BUS UN COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)    1.56 ( 2.51)         PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)    6.04 (  9.72)        GRAMS/TEST       5.639
                CO2  GRAMS/KM (GRAMS/MILE) 1413.25 (2273.93)       GRAMS/KG FUEL    2.64
     CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)   16.98 (27.33)         GRAMS/KM         1.19
                                                                   GRAMS/MILE       1.92

                TOTAL DISTANCE  KM (MILES)     4.729 ( 2.94)
                FUEL CONSUMPTION  KG (LB)      2.132 ( 4.702)      FILTER EFF.     96.27
                FUEL ECONOMY  L/100KM (MPG)    55.52 ( 4.24)
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TABLE D-23. CBD VEHICLE EMISSIONS RESULTS

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                                                   VEHICLE EMISSIONS RESULTS
                                                    PROJECT 03-5428-001

TEST NO.   1       RUN   1                         VEHICLE NO. 2126                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                    DATE   12/ 5/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                       BAG CART NO.  1                   DIESEL    EM-400-F
TRANSMISSION A-3                                   DYNO NO.      4                   ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                           CVS NO.      11

BAROMETER 746.00 MM HG(29.37 IN HG)                DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
RELATIVE HUMIDITY  26. PCT                         ABS. HUMIDITY  5.0 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .91

BAG RESULTS
  TEST CYCLE                                              CBD

  RUN TIME              SECONDS                          579.2
  TOT. BLOWER RATE SCMM (SCFM)                       86.93 ( 3069.4)
  TOT. 20X20 RATE SCMM (SCFM)                        3.27 (115.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                  .03 (   .93)
  TOT FLOW STD. CU. METRES(SCF)                      870.9 ( 30752.)

  HC  SAMPLE METER/RANGE/PPM                         32.0/21/16.01
  HC  BCKGRD METER/RANGE/PPM                         10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM                         37.3/13/34.50
  CO  BCKGRD METER/RANGE/PPM                           .6/13/  .53
  CO2 SAMPLE METER/RANGE/PCT                         82.5/12/.3589
  CO2 BCKGRD METER/RANGE/PCT                         12.2/12/.0414
  NOX SAMPLE METER/RANGE/PPM                         36.2/ 2/36.20
  NOX BCKGRD METER/RANGE/PPM                           .5/ 2/  .50
  DILUTION FACTOR                                         36.83

  HC  CONCENTRATION PPM                                   11.15
  CO  CONCENTRATION PPM                                   33.46
  CO2 CONCENTRATION PCT                                   .3186
  NOX CONCENTRATION PPM                                   35.71
  HC  MASS GRAMS                                           5.598
  CO  MASS GRAMS                                          33.928
  CO2 MASS GRAMS                                        5079.83
  NOX MASS GRAMS                                          53.884
  MASS OF FUEL BURNED GRAMS                             1626.63
  MEASURED DISTANCE  KM (MILES)                      3.233 (2.010)
  FUEL ECONOMY  L/100KM (MPG)                        61.95 ( 3.797)

  HC   GRAMS/KM (GRAMS/MILE)                          1.73 (   2.79)
  CO   GRAMS/KM (GRAMS/MILE)                         10.49 (  16.88)
  CO2  GRAMS/KM (GRAMS/MILE)                        1571.1 (2527.8)
  NOX  GRAMS/KM (GRAMS/MILE)                         16.67 (  26.81)


                                              CBD    COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)       1.73 ( 2.79)                     PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)      10.49 ( 16.88)                    GRAMS/TEST        5.628
                CO2  GRAMS/KM (GRAMS/MILE)    1571.06 (2527.84)                   GRAMS/KG FUEL     3.46
                NOX  GRAMS/KM (GRAMS/MILE)      16.67 (26.81)                     GRAMS/KM          1.74
                                                                                  GRAMS/MILE        2.80


                TOTAL DISTANCE  KM (MILES)       3.233 ( 2.01)
                FUEL CONSUMPTION  KG (LB)        1.627 ( 3.587)                   FILTER EFF.     95.08
                FUEL ECONOMY  L/100KM (MPG)      61.95 ( 3.80)
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TABLE D-23. CBD VEHICLE EMISSIONS RESULTS (Cont'd)

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                                                    PROJECT 03-5428-001

TEST NO.   1        RUN   1                    VEHICLE NO. 2126                         TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    12/ 5/84                         ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                          DIESEL     EM-400-F
TRANSMISSION A-3                               DYNO NO.       4                          D   TER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.       11

BAROMETER 746.00 MM HG(29.37 IN HG)            DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
RELATIVE HUMIDITY  26. PCT                     ABS. HUMIDITY  5.0 GM/KG                 NOX HUMIDITY CORRECTION FACTOR   .91

BAG RESULTS
  TEST CYCLE                                     CBD

  RUN TIME              SECONDS                  579.2
  TOT. BLOWER RATE SCMM (SCFM)                86.93 ( 3069.4)
  TOT. 20X20 RATE SCMM (SCFM)                  3.27 (115.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (  .93)
  TOT FLOW STD. CU. METRES(SCF)               870.9 ( 30752.)

  HC  SAMPLE METER/RANGE/PPM                  32.0/21/16.01
  HC  BCKGRD METER/RANGE/PPM                  10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM                  37.3/13/34.50
  CO  BCKGRD METER/RANGE/PPM                    .6/13/  .53
  CO2 SAMPLE METER/RANGE/PCT                  82.5/12/.3589
  CO2 BCKGRD METER/RANGE/PCT                  12.2/12/.0414
  NOX SAMPLE METER/RANGE/PPM                  39.3/12/39.31
  NOX BCKGRD METER/RANGE/PPM                    .5/ 2/  .50
  DILUTION FACTOR                                36.83

  HC  CONCENTRATION PPM                          11.15
  CO  CONCENTRATION PPM                          33.46
  CO2 CONCENTRATION PCT                          .3186
  NOX CONCENTRATION PPM                          38.82
  HC  MASS GRAMS                                  5.598
  CO  MASS GRAMS                                 33.928
  CO2 MASS GRAMS                               5079.83
  NOX MASS GRAMS                                 58.572
  MASS OF FUEL BURNED GRAMS                    1626.63
  MEASURED DISTANCE  KM (MILES)               3.233 (2.010)
  FUEL ECONOMY  L/100KM (MPG)                 61.95 ( 3.797)

  HC   GRAMS/KM (GRAMS/MILE)                   1.73 (  2.79)
  CO   GRAMS/KM (GRAMS/MILE)                  10.49 ( 16.88)
  CO2  GRAMS/KM (GRAMS/MILE)                 1571.1 (2527.8)
  NOX  GRAMS/KM (GRAMS/MILE)                  18.11 ( 29.15)

                                                 CBD    COMPOSITE RESULTS
                   HC   GRAMS/KM (GRAMS/MILE)     1.73 ( 2.79)                 PARTICULATE RATE
                   CO   GRAMS/KM (GRAMS/MILE)    10.49 ( 16.88)                GRAMS/TEST       5.628
                   CO2  GRAMS/KM (GRAMS/MILE)  1571.06 (2527.84)               GRAMS/KG FUEL    3.46
        CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)    18.11 (29.15)                 GRAMS/KM         1.74
                                                                               GRAMS/MILE       2.80

                   TOTAL DISTANCE  KM (MILES)     3.233 ( 2.01)
                   FUEL CONSUMPTION  KG (LB)      1.627 ( 3.587)               FILTER EFF.     95.08
                   FUEL ECONOMY  L/100KM (MPG)    61.95 ( 3.80)
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                     TABLE D-24.    CBD    VEHICLE EMISSIONS RESULTS
                                            PROJECT 03-5428-001

TEST NO.   2          RUN   1                    VEHICLE NO. 2126                    TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                  DATE    12/ 6/84                    ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                     BAG CART NO.  1                     DIESEL     EM-400-F
TRANSMISSION A-3                                 DYNO NO.       4                    ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                         CVS NO.       11

BAROMETER 758.44 MM HG(29.86 IN HG)              DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR    .88
RELATIVE HUMIDITY  19. PCT                       ABS. HUMIDITY  3.0 GM/KG

BAG RESULTS
   TEST CYCLE                                          CBD

   RUN TIME                   SECONDS                  576.7
   TOT. BLOWER RATE SCMM (SCFM)                     175.68 ( 6203.3)
   TOT. 20X20 RATE SCMM (SCFM)                        3.38 (119.3)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)                   .03 (   .95)
   TOT FLOW STD. CU. METRES(SCF)                    1721.3 ( 60779.)

   HC  SAMPLE METER/RANGE/PPM                        22.5/21/11.27
   HC  BCKGRD METER/RANGE/PPM                        11.2/ 1/ 5.60
   CO  SAMPLE METER/RANGE/PPM                        16.7/13/15.06
   CO  BCKGRD METER/RANGE/PPM                          .1/13/  .09
   CO2 SAMPLE METER/RANGE/PCT                        95.1/13/.2079
   CO2 BCKGRD METER/RANGE/PCT                        22.1/13/.0408
   NOX SAMPLE METER/RANGE/PPM                        65.1/ 1/19.36
   NOX BCKGRD METER/RANGE/PPM                         1.4/ 1/  .41
   DILUTION FACTOR                                     63.65

   HC  CONCENTRATION PPM                               5.76
   CO  CONCENTRATION PPM                              14.82
   CO2 CONCENTRATION PCT                              .1678
   NOX CONCENTRATION PPM                              18.96
   HC  MASS GRAMS                                      5.719
   CO  MASS GRAMS                                     29.697
   CO2 MASS GRAMS                                   5287.82
   NOX MASS GRAMS                                     54.696
   MASS OF FUEL BURNED GRAMS                        1690.34
   MEASURED DISTANCE  KM (MILES)                   3.226 (2.005)
   FUEL ECONOMY  L/100KM (MPG)                     64.53 ( 3.645)

   HC   GRAMS/KM (GRAMS/MILE)                       1.77 (  2.85)
   CO   GRAMS/KM (GRAMS/MILE)                       9.21 ( 14.81)
   CO2  GRAMS/KM (GRAMS/MILE)                     1639.2 (2637.5)
   NOX  GRAMS/KM (GRAMS/MILE)                      16.96 ( 27.28)

                                                  CBD    COMPOSITE RESULTS
                  HC   GRAMS/KM (GRAMS/MILE)      1.77 ( 2.85)                   PARTICULATE RATE
                  CO   GRAMS/KM (GRAMS/MILE)      9.21 ( 14.81)                  GRAMS/TEST        5.536
                  CO2  GRAMS/KM (GRAMS/MILE)   1639.23 (2637.52)                 GRAMS/KG FUEL     3.27
                  NOX  GRAMS/KM (GRAMS/MILE)     16.96 (27.28)                   GRAMS/KM          1.72
                                                                                 GRAMS/MILE        2.76

                  TOTAL DISTANCE  KM (MILES)     3.226 ( 2.00)                   FILTER EFF.     91.36
                  FUEL CONSUMPTION  KG (LB)      1.690 ( 3.727)
                  FUEL ECONOMY  L/100KM (MPG)    64.53 ( 3.65)
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TABLE D-24. CBD VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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TEST NO.   2         RUN   1                      VEHICLE NO. 2126                       TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                   DATE   12/ 6/84                        ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                      BAG CART NO.  1                        DIESEL     EM-400-F
TRANSMISSION A-3                                  DYNO NO.      4                        ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                          CVS NO.      11

BAROMETER 758.44 MM HG(29.86 IN HG)               DRY BULB TEMP. 21.1 DEG C(70.0 DEG F)
RELATIVE HUMIDITY  19. PCT                        ABS. HUMIDITY  3.0 GM/KG               NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
  TEST CYCLE                                          CBD

  RUN TIME                     SECONDS               576.7
  TOT. BLOWER RATE SCMM (SCFM)                    175.68 ( 6203.3)
  TOT. 20X20 RATE SCMM (SCFM)                       3.38 (119.3)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                  .03 (   .95)
  TOT FLOW STD. CU. METRES(SCF)                   1721.3 ( 60779.)

  HC   SAMPLE METER/RANGE/PPM                     22.5/21/11.27
  HC   BCKGRD METER/RANGE/PPM                     11.2/ 1/ 5.60
  CO   SAMPLE METER/RANGE/PPM                     16.7/13/15.06
  CO   BCKGRD METER/RANGE/PPM                       .1/13/  .09
  CO2  SAMPLE METER/RANGE/PCT                     95.1/13/.2079
  CO2  BCKGRD METER/RANGE/PCT                     22.1/13/.0408
  NOX  SAMPLE METER/RANGE/PPM                     21.2/12/21.22
  NOX  BCKGRD METER/RANGE/PPM                      1.4/ 1/  .41
  DILUTION FACTOR                                     63.65

  HC   CONCENTRATION PPM                               5.76
  CO   CONCENTRATION PPM                              14.82
  CO2  CONCENTRATION PCT                              .1678
  NOX  CONCENTRATION PPM                              20.82
  HC   MASS GRAMS                                     5.719
  CO   MASS GRAMS                                    29.697
  CO2  MASS GRAMS                                   5287.82
  NOX  MASS GRAMS                                    60.078
  MASS OF FUEL BURNED GRAMS                         1690.34
  MEASURED DISTANCE  KM (MILES)                   3.226 (2.005)
  FUEL ECONOMY   L/100KM (MPG)                    64.53 ( 3.645)

  HC    GRAMS/KM (GRAMS/MILE)                      1.77 (  2.85)
  CO    GRAMS/KM (GRAMS/MILE)                      9.21 ( 14.81)
  CO2   GRAMS/KM (GRAMS/MILE)                    1639.2 (2637.5)
  NOX   GRAMS/KM (GRAMS/MILE)                     18.62 ( 29.97)

                                                   CBD     COMPOSITE RESULTS
                HC    GRAMS/KM (GRAMS/MILE)         1.77 ( 2.85)                       PARTICULATE RATE
                CO    GRAMS/KM (GRAMS/MILE)         9.21 ( 14.81)                      GRAMS/TEST        5.536
                CO2   GRAMS/KM (GRAMS/MILE)      1639.23 (2637.52)                     GRAMS/KG FUEL     3.27
     CONTINUOUS NOX   GRAMS/KM (GRAMS/MILE)        18.62 (29.97)                       GRAMS/KM          1.72
                                                                                       GRAMS/MILE        2.76


                TOTAL DISTANCE  KM (MILES)       3.226 ( 2.00)
                FUEL CONSUMPTION  KG (LB)        1.690 ( 3.727)                        FILTER EFF.     91.36
                FUEL ECONOMY  L/100KM (MPG)      64.53 ( 3.65)
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                              TABLE D-25.  IDLE   VEHICLE EMISSIONS RESULTS
                                                   PROJECT 03-5428-001
                                                                                       TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.    1        RUN   1                      VEHICLE NO. 2126                     ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                   DATE   12/ 5/84                      DIESEL    EM-400-F
ENGINE  9.0 L( 552. CID) V-6                      BAG CART NO.  1                      ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                                  DYNO NO.      4
GVW16738. KG(36900. LBS)                          CVS NO.      11

BAROMETER 747.27 MM HG(29.42 IN HG)               DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR   .90
RELATIVE HUMIDITY  44. PCT                        ABS. HUMIDITY  4.9 GM/KG

BAG RESULTS
   TEST CYCLE                                         IDLE

   RUN TIME                  SECONDS                 900.1
   TOT. BLOWER RATE SCMM (SCFM)                  87.53 ( 3090.6)
   TOT. 20X20 RATE SCMM (SCFM)                    3.30 (116.5)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)               .03 (   .95)
   TOT FLOW STD. CU. METRES(SCF)                1363.0 ( 48126.)

   HC   SAMPLE METER/RANGE/PPM                   24.1/21/12.03
   HC   BCKGRD METER/RANGE/PPM                    8.5/ 1/ 4.25
   CO   SAMPLE METER/RANGE/PPM                    4.0/13/ 3.55
   CO   BCKGRD METER/RANGE/PPM                     .1/13/  .09
   CO2  SAMPLE METER/RANGE/PCT                   65.2/13/.1319
   CO2  BCKGRD METER/RANGE/PCT                   20.9/13/.0384
   NOX  SAMPLE METER/RANGE/PPM                   56.0/ 1/16.65
   NOX  BCKGRD METER/RANGE/PPM                     .8/ 1/  .23
   DILUTION FACTOR                                 100.39

   HC   CONCENTRATION PPM                            7.82
   CO   CONCENTRATION PPM                            3.41
   CO2  CONCENTRATION PCT                           .0939
   NOX  CONCENTRATION PPM                           16.42
   HC   MASS GRAMS                                  6.148
   CO   MASS GRAMS                                  5.407
   CO2  MASS GRAMS                                2343.69
   NOX  MASS GRAMS                                 38.715
   MASS OF FUEL BURNED GRAMS                       748.96
   MEASURED DISTANCE  KM (MILES)                 .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)                 ****** (  .002)

   HC    GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO    GRAMS/KM (GRAMS/MILE)                 ****** (******)
   CO2   GRAMS/KM (GRAMS/MILE)                 ****** (******)
   NOX   GRAMS/KM (GRAMS/MILE)                  ***** (******)

                                               IDLE   COMPOSITE RESULTS                   PARTICULATE RATE
            HC    GRAMS/KM (GRAMS/MILE)        ***** (*****)                              GRAMS/TEST          1.064
            CO    GRAMS/KM (GRAMS/MILE)       ****** (******)                             GRAMS/KG FUEL        1.42
             O2   GRAMS/KM (GRAMS/MILE)      ******* (*******)                            GRAMS/KM           ******
            NOX   GRAMS/KM (GRAMS/MILE)        ***** (*****)                              GRAMS/MILE         ******

            TOTAL DISTANCE  KM (MILES)         .001 (   .00)                              FILTER EFF.     79.11
            FUEL CONSUMPTION  KG (LB)          .749 ( 1.651)
            FUEL ECONOMY  L/100KM (MPG)      ****** (   .00)
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TABLE D-25. IDLE VEHICLE EMISSIONS RESULTS (Cont'd)

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                                              PROJECT 03-5428-001

TEST NO.   1         RUN   1                 VEHICLE NO. 2126                   TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE    12/ 5/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                    DIESEL     EM-400-F
TRANSMISSION A-3                             DYNO NO.       4                   ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.       11

BAROMETER 747.27 MM HG(29.42 IN HG)          DRY BULB TEMP. 15.6 DEG C(60.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR    .90
RELATIVE HUMIDITY  44. PCT                   ABS. HUMIDITY  4.9 GM/KG

BAG RESULTS                                      IDLE
  TEST CYCLE

  RUN TIME                 SECONDS              900.1
  TOT. BLOWER RATE SCMM (SCFM)               87.53 ( 3090.6)
  TOT. 20X20 RATE SCMM (SCFM)                 3.30 (116.5)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (   .95)
  TOT FLOW STD. CU. METRES(SCF)             1363.0 ( 48126.)

  HC   SAMPLE METER/RANGE/PPM                24.1/21/12.03
  HC   BCKGRD METER/RANGE/PPM                 8.5/ 1/ 4.25
  CO   SAMPLE METER/RANGE/PPM                 4.0/13/ 3.55
  CO   BCKGRD METER/RANGE/PPM                  .1/13/  .09
  CO2  SAMPLE METER/RANGE/PCT                65.2/13/.1319
  CO2  BCKGRD METER/RANGE/PCT                20.9/13/.0384
  NOX  SAMPLE METER/RANGE/PPM                17.3/12/17.26
  NOX  BCKGRD METER/RANGE/PPM                  .8/ 1/  .23
  DILUTION FACTOR                              100.39

  HC   CONCENTRATION PPM                        7.82
  CO   CONCENTRATION PPM                        3.41
  CO2  CONCENTRATION PCT                        .0939
  NOX  CONCENTRATION PPM                       17.03
  HC   MASS GRAMS                               6.148
  CO   MASS GRAMS                               5.407
  CO2  MASS GRAMS                            2343.69
  NOX  MASS GRAMS                              40.154
  MASS OF FUEL BURNED GRAMS                   748.96
  MEASURED DISTANCE  KM (MILES)              .001 ( .000)
  FUEL ECONOMY  L/100KM (MPG)             ****** (  .002)

  HC   GRAMS/KM (GRAMS/MILE)              ****** (******)
  CO   GRAMS/KM (GRAMS/MILE)              ****** (******)
  CO2  GRAMS/KM (GRAMS/MILE)              ****** (******)
  NOX  GRAMS/KM (GRAMS/MILE)               ***** (******)

                                          IDLE   COMPOSITE RESULTS                PARTICULATE RATE
           HC   GRAMS/KM (GRAMS/MILE)     ***** (*****)                           GRAMS/TEST       1.064
           CO   GRAMS/KM (GRAMS/MILE)    ****** (******)                          GRAMS/KG FUEL     1.42
           CO2  GRAMS/KM (GRAMS/MILE)   ******* (*******)                         GRAMS/KM        ******
CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)     ***** (*****)                           GRAMS/MILE      ******

           TOTAL DISTANCE  KM (MILES)       .001 (  .00)                          FILTER EFF.     79.11
           FUEL CONSUMPTION  KG (LB)        .749 ( 1.651)
           FUEL ECONOMY  L/100KM (MPG)    ****** (  .00)
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                              TABLE D-26.IDLE   VEHICLE EMISSIONS RESULTS
                                                  PROJECT 03-5428-001

TEST NO.    2        RUN    1                  VEHICLE NO. 2126              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    12/ 6/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1               DIESEL     EM-400-F
TRANSMISSION A-3                               DYNO NO.      4               ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 759.97 MM HG(29.92 IN HG)            DRY BULB TEMP. 16.1 DEG C(61.0 DEG F)
RELATIVE HUMIDITY  27. PCT                     ABS. HUMIDITY  3.1 GM/KG      NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
   TEST CYCLE                                        IDLE

   RUN TIME               SECONDS                   900.1
   TOT. BLOWER RATE SCMM (SCFM)                 88.85 ( 3137.1)
   TOT. 20X20 RATE SCMM (SCFM)                   3.38 (119.4)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (   .97)
   TOT FLOW STD. CU. METRES(SCF)               1384.0 ( 48869.)

   HC  SAMPLE METER/RANGE/PPM                   22.9/21/11.45
   HC  BCKGRD METER/RANGE/PPM                    8.1/ 1/ 4.05
   CO  SAMPLE METER/RANGE/PPM                    3.6/13/ 3.20
   CO  BCKGRD METER/RANGE/PPM                     .1/13/  .09
   CO2 SAMPLE METER/RANGE/PCT                   64.1/13/.1295
   CO2 BCKGRD METER/RANGE/PCT                   20.5/13/.0376
   NOX SAMPLE METER/RANGE/PPM                   57.9/ 1/17.22
   NOX BCKGRD METER/RANGE/PPM                    1.3/ 1/  .38
   DILUTION FACTOR                                  102.36

   HC  CONCENTRATION PPM                              7.44
   CO  CONCENTRATION PPM                              3.07
   CO2 CONCENTRATION PCT                             .0922
   NOX CONCENTRATION PPM                             16.84
   HC  MASS GRAMS                                     5.934
   CO  MASS GRAMS                                     4.953
   CO2 MASS GRAMS                                  2336.80
   NOX MASS GRAMS                                    39.129
   MASS OF FUEL BURNED GRAMS                        746.35
   MEASURED DISTANCE  KM (MILES)                   .001 ( .000)
   FUEL ECONOMY  L/100KM (MPG)                  ****** (   .002)

   HC   GRAMS/KM (GRAMS/MILE)                   ****** (******)
   CO   GRAMS/KM (GRAMS/MILE)                   ****** (******)
   CO2  GRAMS/KM (GRAMS/MILE)                   ****** (******)
   NOX  GRAMS/KM (GRAMS/MILE)                    ***** (******)

                                                  IDLE   COMPOSITE RESULTS
               HC   GRAMS/KM (GRAMS/MILE)        ***** (*****)                   PARTICULATE RATE
               CO   GRAMS/KM (GRAMS/MILE)       ****** (******)                  GRAMS/TEST          .913
               CO2  GRAMS/KM (GRAMS/MILE)      ******* (*******)                 GRAMS/KG FUEL      1.22
               NOX  GRAMS/KM (GRAMS/MILE)        ***** (*****)                   GRAMS/KM         ******
                                                                                 GRAMS/MILE       ******

               TOTAL DISTANCE  KM (MILES)        .001 (  .00)                    FILTER EFF.     75.82
               FUEL CONSUMPTION  KG (LB)         .746 ( 1.646)
               FUEL ECONOMY  L/100KM (MPG)     ****** (  .00)
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D-2 cont

TABLE D-26. IDLE VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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TEST NO.   2        RUN   1                VEHICLE NO. 2126                  TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04            DATE   12/ 6/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1                   DIESEL    EM-400-F
TRANSMISSION A-3                           DYNO NO.      4                   ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 759.97 MM HG(29.92 IN HG)        DRY BULB TEMP. 16.1 DEG C(61.0 DEG F)
RELATIVE HUMIDITY  27. PCT                 ABS. HUMIDITY  3.1 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
  TEST CYCLE                                     IDLE

  RUN TIME                  SECONDS              900.1
  TOT. BLOWER RATE SCMM (SCFM)                88.85 ( 3137.1)
  TOT. 20X20 RATE SCMM (SCFM)                  3.38 (119.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (   .97)
  TOT FLOW STD. CU. METRES(SCF)              1384.0 ( 48869.)

  HC  SAMPLE METER/RANGE/PPM                  22.9/21/11.45
  HC  BCKGRD METER/RANGE/PPM                   8.1/ 1/ 4.05
  CO  SAMPLE METER/RANGE/PPM                   3.6/13/ 3.20
  CO  BCKGRD METER/RANGE/PPM                    .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT                  64.1/13/.1295
  CO2 BCKGRD METER/RANGE/PCT                  20.5/13/.0376
  NOX SAMPLE METER/RANGE/PPM                  17.2/12/17.20
  NOX BCKGRD METER/RANGE/PPM                   1.3/ 1/  .38
  DILUTION FACTOR                               102.36

  HC  CONCENTRATION PPM                          7.44
  CO  CONCENTRATION PPM                          3.07
  CO2 CONCENTRATION PCT                         .0922
  NOX CONCENTRATION PPM                         16.82
  HC  MASS GRAMS                                 5.934
  CO  MASS GRAMS                                 4.953
  CO2 MASS GRAMS                              2336.80
  NOX MASS GRAMS                                39.085
  MASS OF FUEL BURNED GRAMS                    746.35
  MEASURED DISTANCE  KM (MILES)               .001 ( .000)
  FUEL ECONOMY  L/100KM (MPG)               ****** (  .002)

  HC   GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO   GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO2  GRAMS/KM (GRAMS/MILE)                ****** (******)
  NOX  GRAMS/KM (GRAMS/MILE)                 ***** (******)

                                                IDLE   COMPOSITE RESULTS
                HC   GRAMS/KM (GRAMS/MILE)    ***** (*****)                     PARTICULATE RATE
                CO   GRAMS/KM (GRAMS/MILE)   ****** (******)                    GRAMS/TEST        .913
                CO2  GRAMS/KM (GRAMS/MILE)  ******* (*******)                   GRAMS/KG FUEL     1.22
     CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)    ***** (*****)                     GRAMS/KM        ******
                                                                                GRAMS/MILE      ******

                TOTAL DISTANCE  KM (MILES)      .001 (  .00)                    FILTER EFF.     75.82
                FUEL CONSUMPTION  KG (LB)       .746 ( 1.646)
                FUEL ECONOMY  L/100KM (MPG)   ****** (  .00)
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TABLE D-26. IDLE VEHICLE EMISSIONS RESULTS (Cont'd)

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                                                        PROJECT 03-5428-001

TEST NO.    2        RUN    1                        VEHICLE NO. 2126                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                      DATE    12/ 6/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                         BAG CART NO.  1                  DIESEL     EM-400-F
TRANSMISSION A-3                                     DYNO NO.       4                 ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                             CVS NO.       11

BAROMETER 759.97 MM HG(29.92 IN HG)                  DRY BULB TEMP. 16.1 DEG C(61.0 DEG F)
RELATIVE HUMIDITY  27. PCT                           ABS. HUMIDITY  3.1 GM/KG         NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
  TEST CYCLE                                          IDLE

  RUN TIME                SECONDS                     900.1
  TOT. BLOWER RATE SCMM (SCFM)                     88.85 ( 3137.1)
  TOT. 20X20 RATE SCMM (SCFM)                       3.38 (119.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                  .03 (   .97)
  TOT FLOW STD. CU. METRES(SCF)                   1384.0 ( 48869.)

  HC  SAMPLE METER/RANGE/PPM                       22.9/21/11.45
  HC  BCKGRD METER/RANGE/PPM                        8.1/ 1/ 4.05
  CO  SAMPLE METER/RANGE/PPM                        3.6/13/ 3.20
  CO  BCKGRD METER/RANGE/PPM                         .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT                       64.1/13/.1295
  CO2 BCKGRD METER/RANGE/PCT                       20.5/13/.0376
  NOX SAMPLE METER/RANGE/PPM                       17.2/12/17.20
  NOX BCKGRD METER/RANGE/PPM                        1.3/ 1/  .38
  DILUTION FACTOR                                     102.36

  HC  CONCENTRATION PPM                                 7.44
  CO  CONCENTRATION PPM                                 3.07
  CO2 CONCENTRATION PCT                                .0922
  NOX CONCENTRATION PPM                                16.82
  HC  MASS GRAMS                                        5.934
  CO  MASS GRAMS                                        4.953
  CO2 MASS GRAMS                                     2336.80
  NOX MASS GRAMS                                       39.085
  MASS OF FUEL BURNED GRAMS                           746.35
  MEASURED DISTANCE  KM (MILES)                     .001 ( .000)
  FUEL ECONOMY  L/100KM (MPG)                     ****** (  .002)

  HC   GRAMS/KM (GRAMS/MILE)                      ****** (******)
  CO   GRAMS/KM (GRAMS/MILE)                      ****** (******)
  CO2  GRAMS/KM (GRAMS/MILE)                      ****** (******)
  NOX  GRAMS/KM (GRAMS/MILE)                       ***** (******)


                                                     IDLE   COMPOSITE RESULTS
                  HC   GRAMS/KM (GRAMS/MILE)      ***** (*****)                   PARTICULATE RATE
                  CO   GRAMS/KM (GRAMS/MILE)     ****** (******)                  GRAMS/TEST          .913
                  CO2  GRAMS/KM (GRAMS/MILE)    ******* (*******)                 GRAMS/KG FUEL      1.22
     CONTINUOUS   NOX  GRAMS/KM (GRAMS/MILE)      ***** (*****)                   GRAMS/KM         ******
                                                                                  GRAMS/MILE       ******


                  TOTAL DISTANCE  KM (MILES)       .001 (  .00)
                  FUEL CONSUMPTION  KG (LB)        .746 ( 1.646)                  FILTER EFF.     75.82
                  FUEL ECONOMY  L/100KM (MPG)    ****** (  .00)
```

TABLE D-27. 12.5SS VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   1         RUN   1                 VEHICLE NO. 2126                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE   12/ 5/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                  DIESEL    EM-400-F
TRANSMISSION A-3                             DYNO NO.      4                  ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.      11

BAROMETER 746.51 MM HG(29.39 IN HG)          DRY BULB TEMP. 18.9 DEG C(66.0 DEG F)
RELATIVE HUMIDITY  37. PCT                   ABS. HUMIDITY  5.1 GM/KG          NOX HUMIDITY CORRECTION FACTOR   .91

BAG RESULTS
  TEST CYCLE                                    12.5SS

  RUN TIME                 SECONDS              900.1
  TOT. BLOWER RATE SCMM (SCFM)               86.85 ( 3066.8)
  TOT. 20X20 RATE SCMM (SCFM)                 3.27 (115.5)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (  .93)
  TOT FLOW STD. CU. METRES(SCF)             1352.4 ( 47754.)

  HC  SAMPLE METER/RANGE/PPM                 34.7/21/17.36
  HC  BCKGRD METER/RANGE/PPM                 10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM                 10.0/13/ 8.95
  CO  BCKGRD METER/RANGE/PPM                  3.8/13/ 3.38
  CO2 SAMPLE METER/RANGE/PCT                 97.8/13/.2162
  CO2 BCKGRD METER/RANGE/PCT                 21.5/13/.0396
  NOX SAMPLE METER/RANGE/PPM                 76.6/ 1/22.78
  NOX BCKGRD METER/RANGE/PPM                  1.0/ 1/  .29
  DILUTION FACTOR                               61.23

  HC  CONCENTRATION PPM                         12.44
  CO  CONCENTRATION PPM                          5.52
  CO2 CONCENTRATION PCT                          .1773
  NOX CONCENTRATION PPM                         22.50
  HC  MASS GRAMS                                 9.701
  CO  MASS GRAMS                                 8.695
  CO2 MASS GRAMS                              4390.64
  NOX MASS GRAMS                                52.779
  MASS OF FUEL BURNED GRAMS                   1400.57
  MEASURED DISTANCE  KM (MILES)              5.049 (3.138)
  FUEL ECONOMY  L/100KM (MPG)                34.16 ( 6.886)

  HC   GRAMS/KM (GRAMS/MILE)                  1.92 (  3.09)
  CO   GRAMS/KM (GRAMS/MILE)                  1.72 (  2.77)
  CO2  GRAMS/KM (GRAMS/MILE)                 869.7 (1399.3)
  NOX  GRAMS/KM (GRAMS/MILE)                 10.45 ( 16.82)

                                             12.5SS COMPOSITE RESULTS
            HC   GRAMS/KM (GRAMS/MILE)       1.92 ( 3.09)                 PARTICULATE RATE
            CO   GRAMS/KM (GRAMS/MILE)       1.72 (  2.77)                GRAMS/TEST       2.655
            CO2  GRAMS/KM (GRAMS/MILE)     869.68 (1399.32)               GRAMS/KG FUEL    1.90
            NOX  GRAMS/KM (GRAMS/MILE)      10.45 (16.82)                 GRAMS/KM          .53
                                                                          GRAMS/MILE        .85

            TOTAL DISTANCE  KM (MILES)      5.049 ( 3.14)
            FUEL CONSUMPTION  KG (LB)       1.401 ( 3.088)                FILTER EFF.     94.44
            FUEL ECONOMY  L/100KM (MPG)     34.16 ( 6.89)
```

TABLE D-27. 12.5SS VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

```
TEST NO.   1        RUN   1                  VEHICLE NO. 2126                    TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE   12/ 5/84                     ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                     DIESEL    EM-400-F
TRANSMISSION A-3                             DYNO NO.      4                     ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.       11

BAROMETER 746.51 MM HG(29.39 IN HG)          DRY BULB TEMP. 18.9 DEG C(66.0 DEG F)
RELATIVE HUMIDITY  37. PCT                   ABS. HUMIDITY  5.1 GM/KG            NOX HUMIDITY CORRECTION FACTOR   .91

BAG RESULTS
  TEST CYCLE                                      12.5SS

  RUN TIME              SECONDS                   900.1
  TOT. BLOWER RATE SCMM (SCFM)                 86.85 ( 3066.8)
  TOT. 20X20 RATE SCMM (SCFM)                   3.27 (115.5)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (  .93)
  TOT FLOW STD. CU. METRES(SCF)               1352.4 ( 47754.)

  HC  SAMPLE METER/RANGE/PPM                   34.7/21/17.36
  HC  BCKGRD METER/RANGE/PPM                   10.0/ 1/ 5.00
  CO  SAMPLE METER/RANGE/PPM                   10.0/13/ 8.95
  CO  BCKGRD METER/RANGE/PPM                    3.8/13/ 3.38
  CO2 SAMPLE METER/RANGE/PCT                   97.8/13/.2162
  CO2 BCKGRD METER/RANGE/PCT                   21.5/13/.0396
  NOX SAMPLE METER/RANGE/PPM                   24.3/12/24.35
  NOX BCKGRD METER/RANGE/PPM                    1.0/ 1/  .29
  DILUTION FACTOR                                 61.23

  HC  CONCENTRATION PPM                           12.44
  CO  CONCENTRATION PPM                            5.52
  CO2 CONCENTRATION PCT                           .1773
  NOX CONCENTRATION PPM                           24.06
  HC  MASS GRAMS                                   9.701
  CO  MASS GRAMS                                   8.695
  CO2 MASS GRAMS                                4390.64
  NOX MASS GRAMS                                  56.461
  MASS OF FUEL BURNED GRAMS                     1400.57
  MEASURED DISTANCE  KM (MILES)                5.049 (3.138)
  FUEL ECONOMY  L/100KM (MPG)                  34.16 ( 6.886)

  HC   GRAMS/KM (GRAMS/MILE)                    1.92 (  3.09)
  CO   GRAMS/KM (GRAMS/MILE)                    1.72 (  2.77)
  CO2  GRAMS/KM (GRAMS/MILE)                   869.7 (1399.3)
  NOX  GRAMS/KM (GRAMS/MILE)                   11.18 ( 17.99)


                                             12.5SS COMPOSITE RESULTS
                     HC   GRAMS/KM (GRAMS/MILE)    1.92 ( 3.09)                PARTICULATE RATE
                     CO   GRAMS/KM (GRAMS/MILE)    1.72 (  2.77)               GRAMS/TEST        2.655
                     CO2  GRAMS/KM (GRAMS/MILE)  869.68 (1399.32)              GRAMS/KG FUEL     1.90
          CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)   11.18 (17.99)                GRAMS/KM           .53
                                                                               GRAMS/MILE         .85


                     TOTAL DISTANCE  KM (MILES)      5.049 ( 3.14)
                     FUEL CONSUMPTION  KG (LB)       1.401 ( 3.088)            FILTER EFF.    94.44
                     FUEL ECONOMY  L/100KM (MPG)     34.16 ( 6.89)
```

TABLE D-28.12.5SS VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   2        RUN   1                    VEHICLE NO. 2126                         TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE   12/ 6/84                          ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                          DIESEL     EM-400-F
TRANSMISSION A-3                               DYNO NO.      4                          ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 759.46 MM HG(29.90 IN HG)            DRY BULB TEMP. 17.8 DEG C(64.0 DEG F)
RELATIVE HUMIDITY  27. PCT                     ABS. HUMIDITY  3.3 GM/KG                 NOX HUMIDITY CORRECTION FACTOR   .88

BAG RESULTS
  TEST CYCLE                                    12.5SS

  RUN TIME                  SECONDS              900.1
  TOT. BLOWER RATE SCMM (SCFM)                89.19 ( 3149.4)
  TOT. 20X20 RATE SCMM (SCFM)                  3.36 (118.8)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (   .97)
  TOT FLOW STD. CU. METRES(SCF)              1388.9 ( 49042.)

  HC  SAMPLE METER/RANGE/PPM                 37.1/21/18.56
  HC  BCKGRD METER/RANGE/PPM                 10.7/ 1/ 5.35
  CO  SAMPLE METER/RANGE/PPM                  6.8/13/ 6.06
  CO  BCKGRD METER/RANGE/PPM                   .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT                 99.1/13/.2204
  CO2 BCKGRD METER/RANGE/PCT                 22.6/13/.0418
  NOX SAMPLE METER/RANGE/PPM                 79.0/ 1/23.49
  NOX BCKGRD METER/RANGE/PPM                  1.7/ 1/  .50
  DILUTION FACTOR                                60.13

  HC  CONCENTRATION PPM                          13.30
  CO  CONCENTRATION PPM                           5.90
  CO2 CONCENTRATION PCT                          .1793
  NOX CONCENTRATION PPM                          23.00
  HC  MASS GRAMS                                10.649
  CO  MASS GRAMS                                 9.535
  CO2 MASS GRAMS                               4560.57
  NOX MASS GRAMS                                53.880
  MASS OF FUEL BURNED GRAMS                    1455.60
  MEASURED DISTANCE  KM (MILES)              5.058 (3.144)
  FUEL ECONOMY  L/100KM (MPG)                35.44 ( 6.638)

  HC    GRAMS/KM (GRAMS/MILE)                 2.11 (   3.39)
  CO    GRAMS/KM (GRAMS/MILE)                 1.89 (   3.03)
  CO2   GRAMS/KM (GRAMS/MILE)                901.6 (1450.7)
  NOX   GRAMS/KM (GRAMS/MILE)                10.65 ( 17.14)

                                                12.5SS COMPOSITE RESULTS
              HC   GRAMS/KM (GRAMS/MILE)      2.11 ( 3.39)                   PARTICULATE RATE
              CO   GRAMS/KM (GRAMS/MILE)      1.89 (  3.03)                  GRAMS/TEST       2.295
              CO2  GRAMS/KM (GRAMS/MILE)    901.62 (1450.70)                 GRAMS/KG FUEL    1.58
              NOX  GRAMS/KM (GRAMS/MILE)     10.65 (17.14)                   GRAMS/KM          .45
                                                                               ᴬMS/MILE        .73

              TOTAL DISTANCE  KM (MILES)     5.058 ( 3.14)
              FUEL CONSUMPTION  KG (LB)      1.456 ( 3.210)                  FILTER EFF.     90.29
              FUEL ECONOMY  L/100KM (MPG)    35.44 ( 6.64)
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TABLE D-28. 12.5SS VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

```
                                                                              TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.    2        RUN   1               VEHICLE NO. 2126                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04            DATE   12/ 6/84                    DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1                    ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                           DYNO NO.      4
GVW16738. KG(36900. LBS)                   CVS NO.      11

                                           DRY BULB TEMP. 17.8 DEG C(64.0 DEG F)
BAROMETER 759.46 MM HG(29.90 IN HG)        ABS. HUMIDITY  3.3 GM/KG           NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  27. PCT

BAG RESULTS                                     12.5SS
  TEST CYCLE

  RUN TIME                 SECONDS              900.1
  TOT. BLOWER RATE SCMM (SCFM)               89.19 ( 3149.4)
  TOT. 20X20 RATE SCMM (SCFM)                 3.36 (118.8)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (   .97)
  TOT FLOW STD. CU. METRES(SCF)             1388.9 ( 49042.)

  HC  SAMPLE METER/RANGE/PPM                 37.1/21/18.56
  HC  BCKGRD METER/RANGE/PPM                 10.7/ 1/ 5.35
  CO  SAMPLE METER/RANGE/PPM                  6.8/13/ 6.06
  CO  BCKGRD METER/RANGE/PPM                   .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT                 99.1/13/.2204
  CO2 BCKGRD METER/RANGE/PCT                 22.6/13/.0418
  NOX SAMPLE METER/RANGE/PPM                 25.1/12/25.12
  NOX BCKGRD METER/RANGE/PPM                  1.7/ 1/  .50
  DILUTION FACTOR                               60.13

  HC  CONCENTRATION PPM                         13.30
  CO  CONCENTRATION PPM                          5.90
  CO2 CONCENTRATION PCT                          .1793
  NOX CONCENTRATION PPM                         24.63
  HC  MASS GRAMS                                10.649
  CO  MASS GRAMS                                 9.535
  CO2 MASS GRAMS                              4560.57
  NOX MASS GRAMS                                57.682
  MASS OF FUEL BURNED GRAMS                   1455.60
  MEASURED DISTANCE  KM (MILES)              5.058 (3.144)
  FUEL ECONOMY  L/100KM (MPG)                35.44 ( 6.638)

  HC   GRAMS/KM (GRAMS/MILE)                  2.11 (  3.39)
  CO   GRAMS/KM (GRAMS/MILE)                  1.89 (  3.03)
  CO2  GRAMS/KM (GRAMS/MILE)                 901.6 (1450.7)
  NOX  GRAMS/KM (GRAMS/MILE)                 11.40 ( 18.35)

                                          12.5SS COMPOSITE RESULTS            PARTICULATE RATE
                  HC   GRAMS/KM (GRAMS/MILE)    2.11 ( 3.39)                  GRAMS/TEST        2.295
                  CO   GRAMS/KM (GRAMS/MILE)    1.89 (  3.03)                 GRAMS/KG FUEL     1.58
                  CO2  GRAMS/KM (GRAMS/MILE)  901.62 (1450.70)                GRAMS/KM           .45
       CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)   11.40 (18.35)                  GRAMS/MILE         .73


                  TOTAL DISTANCE  KM (MILES)     5.058 ( 3.14)                FILTER EFF.     90.29
                  FUEL CONSUMPTION  KG (LB)      1.456 ( 3.210)
                  FUEL ECONOMY  L/100KM (MPG)    35.44 ( 6.64)
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                         TABLE D-29. 25 SS  VEHICLE EMISSIONS RESULTS
                                            PROJECT 03-5428-001

                                                                                   TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.    1          RUN    1                      VEHICLE NO. 2126              'CTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                      DATE    12/ 5/84              DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                         BAG CART NO.  1               ODOMETER 155496. KM( 96621. MILES)
TRANSMISSION A-3                                     DYNO NO.      4
GVW16738. KG(36900. LBS)                             CVS NO.      11

BAROMETER 746.00 MM HG(29.37 IN HG)                  DRY BULB TEMP. 17.8 DEG C(64.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR    .91
RELATIVE HUMIDITY  39. PCT                           ABS. HUMIDITY  5.0 GM/KG

BAG RESULTS                                              25 SS
   TEST CYCLE

   RUN TIME                  SECONDS                     900.2
   TOT. BLOWER RATE SCMM (SCFM)                        86.66 ( 3060.0)
   TOT. 20X20 RATE SCMM (SCFM)                          3.27 (115.6)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)                     .03 (   .95)
   TOT FLOW STD. CU. METRES(SCF)                      1349.7 ( 47660.)

   HC  SAMPLE METER/RANGE/PPM                          41.0/21/20.52
   HC  BCKGRD METER/RANGE/PPM                          10.0/ 1/ 5.00
   CO  SAMPLE METER/RANGE/PPM                          11.0/13/ 9.85
   CO  BCKGRD METER/RANGE/PPM                           2.4/13/ 2.13
   CO2 SAMPLE METER/RANGE/PCT                          74.4/12/.3145
   CO2 BCKGRD METER/RANGE/PCT                          12.5/12/.0425
   NOX SAMPLE METER/RANGE/PPM                          30.2/ 2/30.20
   NOX BCKGRD METER/RANGE/PPM                            .5/ 2/  .50
   DILUTION FACTOR                                        42.21

   HC  CONCENTRATION PPM                                  15.64
   CO  CONCENTRATION PPM                                   7.62
   CO2 CONCENTRATION PCT                                  .2730
   NOX CONCENTRATION PPM                                  29.71
   HC  MASS GRAMS                                        12.174
   CO  MASS GRAMS                                        11.969
   CO2 MASS GRAMS                                       6745.44
   NOX MASS GRAMS                                        69.501
   MASS OF FUEL BURNED GRAMS                            2148.31
   MEASURED DISTANCE  KM (MILES)                     ***** (6.244)
   FUEL ECONOMY  L/100KM (MPG)                       26.33 ( 8.934)

   HC   GRAMS/KM (GRAMS/MILE)                         1.21 (  1.95)
   CO   GRAMS/KM (GRAMS/MILE)                         1.19 (  1.92)
   CO2  GRAMS/KM (GRAMS/MILE)                        671.4 (1080.3)
   NOX  GRAMS/KM (GRAMS/MILE)                         6.92 ( 11.13)

                                          25 SS  COMPOSITE RESULTS                     PARTICULATE RATE
               HC   GRAMS/KM (GRAMS/MILE)     1.21 ( 1.95)                             GRAMS/TEST        4.639
               CO   GRAMS/KM (GRAMS/MILE)     1.19 (  1.92)                            GRAMS/KG FUEL     2.16
               CO2  GRAMS/KM (GRAMS/MILE)   671.39 (1080.27)                           GRAMS/KM           .46
               NOX  GRAMS/KM (GRAMS/MILE)     6.92 (11.13)                             GRAMS/MILE         .74


               TOTAL DISTANCE  KM (MILES)       ***** ( 6.24)                          FILTER EFF.     95.86
               FUEL CONSUMPTION  KG (LB)        2.148 ( 4.737)
               FUEL ECONOMY  L/100KM (MPG)      26.33 ( 8.93)
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TABLE D-29. 25 SS VEHICLE EMISSIONS RESULTS (Cont'd)

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                                                   PROJECT 03-5428-001

TEST NO.    1        RUN   1                 VEHICLE NO. 2126              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE   12/ 5/84               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1               DIESEL     EM-400-F
TRANSMISSION A-3                             DYNO NO.       4              ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.       11

BAROMETER 746.00 MM HG(29.37 IN HG)          DRY BULB TEMP. 17.8 DEG C(64.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR   .91
RELATIVE HUMIDITY  39. PCT                   ABS. HUMIDITY  5.0 GM/KG

BAG RESULTS
  TEST CYCLE                                       25 SS

  RUN TIME               SECONDS                   900.2
  TOT. BLOWER RATE SCMM (SCFM)                 86.66 ( 3060.0)
  TOT. 20X20 RATE SCMM (SCFM)                   3.27 (115.6)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (   .95)
  TOT FLOW STD. CU. METRES(SCF)               1349.7 ( 47660.)

  HC   SAMPLE METER/RANGE/PPM                  41.0/21/20.52
  HC   BCKGRD METER/RANGE/PPM                  10.0/ 1/ 5.00
  CO   SAMPLE METER/RANGE/PPM                  11.0/13/ 9.85
  CO   BCKGRD METER/RANGE/PPM                   2.4/13/ 2.13
  CO2  SAMPLE METER/RANGE/PCT                  74.4/12/.3145
  CO2  BCKGRD METER/RANGE/PCT                  12.5/12/.0425
  NOX  SAMPLE METER/RANGE/PPM                  31.4/12/31.45
  NOX  BCKGRD METER/RANGE/PPM                    .5/ 2/  .50
  DILUTION FACTOR                                  42.21

  HC   CONCENTRATION PPM                           15.64
  CO   CONCENTRATION PPM                            7.62
  CO2  CONCENTRATION PCT                           .2730
  NOX  CONCENTRATION PPM                           30.96
  HC   MASS GRAMS                                  12.174
  CO   MASS GRAMS                                  11.969
  CO2  MASS GRAMS                                6745.44
  NOX  MASS GRAMS                                  72.422
  MASS OF FUEL BURNED GRAMS                      2148.31
  MEASURED DISTANCE  KM (MILES)                ***** (6.244)
  FUEL ECONOMY  L/100KM (MPG)                  26.33 ( 8.934)

  HC    GRAMS/KM (GRAMS/MILE)                   1.21 (  1.95)
  CO    GRAMS/KM (GRAMS/MILE)                   1.19 (  1.92)
  CO2   GRAMS/KM (GRAMS/MILE)                  671.4 (1080.3)
  NOX   GRAMS/KM (GRAMS/MILE)                   7.21 ( 11.60)

                                                   25 SS  COMPOSITE RESULTS
                    HC    GRAMS/KM (GRAMS/MILE)      1.21 ( 1.95)             PARTICULATE RATE
                    CO    GRAMS/KM (GRAMS/MILE)      1.19 (  1.92;            GRAMS/TEST      4.639
                    CO2   GRAMS/KM (GRAMS/MILE)    671.39 (1080.27)           GRAMS/KG FUEL    2.16
       CONTINUOUS   NOX   GRAMS/KM (GRAMS/MILE)      7.21 (11.60)             GRAMS/KM          .46
                                                                              GRAMS/MILE        .74

                    TOTAL DISTANCE  KM (MILES)       ***** ( 6.24)            FILTER EFF.     95.86
                    FUEL CONSUMPTION  KG (LB)        2.148 ( 4.737)
                    FUEL ECONOMY  L/100KM (MPG)      26.33 ( 8.93)
```

TABLE D-30. 25 SS VEHICLE EMISSIONS RESULTS

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                                        PROJECT 03-5428-001

TEST NO.   2        RUN   1             VEHICLE NO. 2126            TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04         DATE   12/ 6/84             ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6            BAG CART NO.  1             DIESEL    EM-400-F
TRANSMISSION A-3                        DYNO NO.      4             ODOMETER 155496. KM( 96621. MILES)
GVW16738. KG(36900. LBS)                CVS NO.      11

BAROMETER 758.95 MM HG(29.88 IN HG)     DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR   .88
RELATIVE HUMIDITY  21. PCT              ABS. HUMIDITY  3.2 GM/KG

BAG RESULTS
  TEST CYCLE                                      25 SS

  RUN TIME                  SECONDS               900.1
  TOT. BLOWER RATE SCMM (SCFM)                 88.96 ( 3141.2)
  TOT. 20X20 RATE SCMM (SCFM)                   3.37 (118.9)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)              .03 (   .96)
  TOT FLOW STD. CU. METRES(SCF)               1385.5 ( 48921.)

  HC  SAMPLE METER/RANGE/PPM                  40.7/21/20.37
  HC  BCKGRD METER/RANGE/PPM                  11.9/ 1/ 5.95
  CO  SAMPLE METER/RANGE/PPM                   8.6/13/ 7.68
  CO  BCKGRD METER/RANGE/PPM                    .1/13/  .09
  CO2 SAMPLE METER/RANGE/PCT                  74.5/12/.3150
  CO2 BCKGRD METER/RANGE/PCT                  13.3/12/.0454
  NOX SAMPLE METER/RANGE/PPM                  31.0/ 2/31.00
  NOX BCKGRD METER/RANGE/PPM                    .7/ 2/  .70
  DILUTION FACTOR                                 42.17

  HC  CONCENTRATION PPM                           14.56
  CO  CONCENTRATION PPM                            7.50
  CO2 CONCENTRATION PCT                           .2707
  NOX CONCENTRATION PPM                           30.32
  HC  MASS GRAMS                                  11.629
  CO  MASS GRAMS                                  12.091
  CO2 MASS GRAMS                                 6866.50
  NOX MASS GRAMS                                  70.663
  MASS OF FUEL BURNED GRAMS                      2186.06
  MEASURED DISTANCE  KM (MILES)                ***** (6.236)
  FUEL ECONOMY  L/100KM (MPG)                  26.83 ( 8.769)

  HC    GRAMS/KM (GRAMS/MILE)                   1.16 (  1.86)
  CO    GRAMS/KM (GRAMS/MILE)                   1.20 (  1.94)
  CO2   GRAMS/KM (GRAMS/MILE)                  684.3 (1101.0)
  NOX   GRAMS/KM (GRAMS/MILE)                   7.04 ( 11.33)

                                         25 SS  COMPOSITE RESULTS               PARTICULATE RATE
            HC   GRAMS/KM (GRAMS/MILE)      1.16 ( 1.86)                        GRAMS/TEST        4.120
            CO   GRAMS/KM (GRAMS/MILE)      1.20 (  1.94)                       GRAMS/KG FUEL     1.88
            CO2  GRAMS/KM (GRAMS/MILE)    684.29 (1101.02)                      GRAMS/KM           .41
            NOX  GRAMS/KM (GRAMS/MILE)      7.04 (11.33)                        GRAMS/MILE         .66


            TOTAL DISTANCE  KM (MILES)     ***** ( 6.24)                        FILTER EFF.     90.57
            FUEL CONSUMPTION  KG (LB)      2.186 ( 4.820)
            FUEL ECONOMY  L/100KM (MPG)    26.83 ( 8.77)
```

TABLE D-30. 25 SS VEHICLE EMISSIONS RESULTS (Cont'd)

```
                                                        PROJECT 03-5428-001
                                                                                   TEST WEIGHT 13608. KG(30000. LBS)
                                                    VEHICLE NO. 2126               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
TEST NO.   2          RUN   1                       DATE   12/ 6/84                DIESEL     EM-400-F
VEHICLE MODEL 1983 GMC RTSII 04                     BAG CART NO.  1                ODOMETER 155496. KM( 96621. MILES)
ENGINE  9.0 L( 552. CID) V-6                        DYNO NO.      4
TRANSMISSION A-3                                    CVS NO.      11
GVW16738. KG(36900. LBS)
                                                    DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)
BAROMETER 758.95 MM HG(29.88 IN HG)                 ABS. HUMIDITY  3.2 GM/KG       NOX HUMIDITY CORRECTION FACTOR    .88
RELATIVE HUMIDITY  21. PCT

BAG RESULTS                                              25 SS
  TEST CYCLE
                                                        900.1
  RUN TIME                   SECONDS                 88.96 ( 3141.2)
  TOT. BLOWER RATE SCMM (SCFM)                        3.37 (118.9)
  TOT. 20X20 RATE SCMM (SCFM)                          .03 (  .96)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)                1385.5 ( 48921.)
  TOT FLOW STD. CU. METRES(SCF)
                                                     40.7/21/20.37
  HC  SAMPLE METER/RANGE/PPM                         11.9/ 1/ 5.95
  HC  BCKGRD METER/RANGE/PPM                          8.6/13/ 7.68
  CO  SAMPLE METER/RANGE/PPM                           .1/13/  .09
  CO  BCKGRD METER/RANGE/PPM                         74.5/12/.3150
  CO2 SAMPLE METER/RANGE/PCT                         13.3/12/.0454
  CO2 BCKGRD METER/RANGE/PCT                         32.7/12/32.67
  NOX SAMPLE METER/RANGE/PPM                           .7/ 2/  .70
  NOX BCKGRD METER/RANGE/PPM                            42.17
  DILUTION FACTOR
                                                        14.56
  HC  CONCENTRATION PPM                                  7.50
  CO  CONCENTRATION PPM                                 .2707
  CO2 CONCENTRATION PCT                                 31.98
  NOX CONCENTRATION PPM                                 11.629
  HC  MASS GRAMS                                        12.091
  CO  MASS GRAMS                                      6866.50
  CO2 MASS GRAMS                                        74.552
  NOX MASS GRAMS                                      2186.06
  MASS OF FUEL BURNED GRAMS                        ***** (6.236)
  MEASURED DISTANCE  KM (MILES)                     26.83 ( 8.769)
  FUEL ECONOMY  L/100KM (MPG)
                                                      1.16 (  1.86)
  HC   GRAMS/KM (GRAMS/MILE)                          1.20 (  1.94)
  CO   GRAMS/KM (GRAMS/MILE)                        684.3 (1101.0)
  CO2  GRAMS/KM (GRAMS/MILE)                          7.43 ( 11.95)
  NOX  GRAMS/KM (GRAMS/MILE)

                                                     25 SS  COMPOSITE RESULTS                PARTICULATE RATE
                   HC   GRAMS/KM (GRAMS/MILE)          1.16 ( 1.86)                          GRAMS/TEST       4.120
                   CO   GRAMS/KM (GRAMS/MILE)          1.20 (  1.94)                         GRAMS/KG FUEL    1.88
                   CO2  GRAMS/KM (GRAMS/MILE)        684.29 (1101.02)                        GRAMS/KM          .41
        CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)          7.43 (11.95)                          GRAMS/MILE        .66


                   TOTAL DISTANCE  KM (MILES)        ***** ( 6.24)                           FILTER EFF.     90.57
                   FUEL CONSUMPTION  KG (LB)          2.186 ( 4.820)
                   FUEL ECONOMY  L/100KM (MPG)        26.83 ( 8.77)
```

TABLE D-31. C-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

```
TEST NO.   1        RUN   1              VEHICLE NO. 1934                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04          DATE    12/12/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6             BAG CART NO.  1                  DIESEL     EM-400-F
TRANSMISSION A-3                         DYNO NO.      4                  ODOMETER 223346. KM(138781. MILES)
GVW16738. KG(36900. LBS)                 CVS NO.      11

BAROMETER 733.81 MM HG(28.89 IN HG)      DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)     NOX HUMIDITY CORRECTION FACTOR  1.00
RELATIVE HUMIDITY  58. PCT               ABS. HUMIDITY 10.8 GM/KG
BAG RESULTS
  BAG NUMBER                                   1                  2                  3                  4
  DESCRIPTION                                NYNF               LANF                LAF               NYNF

  RUN TIME                  SECONDS           254.0              285.0              267.0              262.0
  TOT. BLOWER RATE SCMM (SCFM)        251.40 ( 8877.1)   251.35 ( 8875.3)   251.39 ( 8876.6)   251.37 ( 8875.9)
  TOT. 20X20 RATE SCMM (SCFM)           3.17 (112.0)       3.17 (112.0)       3.17 (112.0)       3.17 (112.0)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)      .03 ( 1.22)        .03 ( 1.22)        .03 ( 1.22)        .03 ( 1.22)
  TOT FLOW STD. CU. METRES(SCF)      1077.9 ( 38059.)   1209.2 ( 42696.)   1133.0 ( 40005.)   1111.7 ( 39253.)

  HC  SAMPLE METER/RANGE/PPM          21.4/21/10.72      23.8/21/11.90      29.7/21/14.83      20.0/21/10.00
  HC  BCKGRD METER/RANGE/PPM          11.2/ 1/ 5.60      11.6/ 1/ 5.80      11.8/ 1/ 5.90      11.5/ 1/ 5.75
  CO  SAMPLE METER/RANGE/PPM          15.5/13/13.96      16.2/13/14.60      26.9/13/24.56      13.5/13/12.13
  CO  BCKGRD METER/RANGE/PPM            .4/13/  .35        .6/13/  .53        .8/13/  .71        .3/13/  .27
  CO2 SAMPLE METER/RANGE/PCT          64.0/13/.1292      75.7/13/.1563      77.3/12/.3300      60.3/13/.1210
  CO2 BCKGRD METER/RANGE/PCT          24.6/13/.0457      23.9/13/.0443      13.3/12/.0454      21.5/13/.0396
  NOX SAMPLE METER/RANGE/PPM          19.6/ 1/ 5.82      27.2/ 1/ 8.08      60.9/ 1/18.11      24.8/ 1/ 7.37
  NOX BCKGRD METER/RANGE/PPM            .7/ 1/  .20        .5/ 1/  .14        .7/ 1/  .20        .7/ 1/  .20
  DILUTION FACTOR                        101.77              84.33              40.13             108.77

  HC  CONCENTRATION PPM                    5.17               6.17               9.08               4.31
  CO  CONCENTRATION PPM                   13.32              13.77              23.26              11.61
  CO2 CONCENTRATION PCT                   .0839              .1125              .2858              .0818
  NOX CONCENTRATION PPM                    5.62               7.94              17.91               7.17
  HC  MASS GRAMS                          3.213              4.300              5.931              2.760
  CO  MASS GRAMS                         16.710             19.379             30.683             15.030
  CO2 MASS GRAMS                        1656.39            2489.74            5928.51            1664.81
  NOX MASS GRAMS                         11.618             18.409             38.893             15.277
  MASS OF FUEL BURNED GRAMS              534.59             800.17            1893.37             535.96
  MEASURED DISTANCE  KM (MILES)       .753 ( .468)     1.837 (1.142)      5.366 (3.335)       .871 ( .541)
  FUEL ECONOMY  L/100KM (MPG)        87.37 ( 2.692)    53.63 ( 4.386)     43.45 ( 5.414)     75.77 ( 3.105)

  HC    GRAMS/KM (GRAMS/MILE)         4.26 (  6.86)      2.34 (  3.77)      1.11 (  1.78)      3.17 (  5.10)
  CO    GRAMS/KM (GRAMS/MILE)        22.18 ( 35.68)     10.55 ( 16.97)      5.72 (  9.20)     17.25 ( 27.76)
  CO2   GRAMS/KM (GRAMS/MILE)       2198.4 (3537.2)     1355.2 (2180.5)    1104.9 (1777.7)    1911.1 (3074.9)
  NOX   GRAMS/KM (GRAMS/MILE)        15.42 ( 24.81)     10.02 ( 16.12)      7.25 ( 11.66)     17.54 ( 28.22)

                                    C-TRAN COMPOSITE RESULTS
                 HC   GRAMS/KM (GRAMS/MILE)      1.84 ( 2.95)                 PARTICULATE RATE
                 CO   GRAMS/KM (GRAMS/MILE)      9.27 ( 14.91)                GRAMS/TEST        28.566
                 CO2  GRAMS/KM (GRAMS/MILE)   1329.86 (2139.74)               GRAMS/KG FUEL      7.59
                 NOX  GRAMS/KM (GRAMS/MILE)      9.54 (15.35)                 GRAMS/KM           3.24
                                                                              GRAMS/MILE         5.21

                 TOTAL DISTANCE  KM (MILES)      8.828 ( 5.49)                FILTER EFF.      95.35
                 FUEL CONSUMPTION  KG (LB)       3.764 ( 8.300)
                 FUEL ECONOMY  L/100KM (MPG)     52.51 ( 4.48)
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TABLE D-31. C-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 1934
DATE 12/12/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 223346. KM(138781. MILES)

BAROMETER 733.81 MM HG(28.89 IN HG)
RELATIVE HUMIDITY 58. PCT

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 10.8 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.00

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	251.40 (8877.1)	251.35 (8875.3)	251.39 (8876.6)	251.37 (8875.9)
TOT. 20X20 RATE SCMM (SCFM)	3.17 (112.0)	3.17 (112.0)	3.17 (112.0)	3.17 (112.0)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.03 (1.22)	.03 (1.22)	.03 (1.22)	.03 (1.22)
TOT FLOW STD. CU. METRES(SCF)	1077.9 (38059.)	1209.2 (42696.)	1133.0 (40005.)	1111.7 (39253.)
HC SAMPLE METER/RANGE/PPM	21.4/21/10.72	23.8/21/11.90	29.7/21/14.83	20.0/21/10.00
HC BCKGRD METER/RANGE/PPM	11.2/ 1/ 5.60	11.6/ 1/ 5.80	11.8/ 1/ 5.90	11.5/ 1/ 5.75
CO SAMPLE METER/RANGE/PPM	15.5/13/13.96	16.2/13/14.60	26.9/13/24.56	13.5/13/12.13
CO BCKGRD METER/RANGE/PPM	.4/13/ .35	.6/13/ .53	.8/13/ .71	.3/13/ .27
CO2 SAMPLE METER/RANGE/PCT	64.0/13/.1292	75.7/13/.1563	77.3/12/.3300	60.3/13/.1210
CO2 BCKGRD METER/RANGE/PCT	24.6/13/.0457	23.9/13/.0443	13.3/12/.0454	21.5/13/.0396
NOX SAMPLE METER/RANGE/PPM	6.8/12/ 6.80	8.4/12/ 8.39	19.1/12/19.09	7.4/12/ 7.36
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .20	.5/ 1/ .14	.7/ 1/ .20	.7/ 1/ .20
DILUTION FACTOR	101.77	84.33	40.13	108.77
HC CONCENTRATION PPM	5.17	6.17	9.08	4.31
CO CONCENTRATION PPM	13.32	13.77	23.26	11.61
CO2 CONCENTRATION PCT	.0839	.1125	.2858	.0818
NOX CONCENTRATION PPM	6.60	8.25	18.90	7.17
HC MASS GRAMS	3.213	4.300	5.931	2.760
CO MASS GRAMS	16.710	19.379	30.683	15.030
CO2 MASS GRAMS	1656.39	2489.74	5928.51	1664.81
NOX MASS GRAMS	13.642	19.112	41.027	15.266
MASS OF FUEL BURNED GRAMS	534.59	800.17	1893.37	535.96
MEASURED DISTANCE KM (MILES)	.753 (.468)	1.837 (1.142)	5.366 (3.335)	.871 (.541)
FUEL ECONOMY L/100KM (MPG)	87.37 (2.692)	53.63 (4.386)	43.45 (5.414)	75.77 (3.105)
HC GRAMS/KM (GRAMS/MILE)	4.26 (6.86)	2.34 (3.77)	1.11 (1.78)	3.17 (5.10)
CO GRAMS/KM (GRAMS/MILE)	22.18 (35.68)	10.55 (16.97)	5.72 (9.20)	17.25 (27.76)
CO2 GRAMS/KM (GRAMS/MILE)	2198.4 (3537.2)	1355.2 (2180.5)	1104.9 (1777.7)	1911.1 (3074.9)
NOX GRAMS/KM (GRAMS/MILE)	18.11 (29.13)	10.40 (16.74)	7.65 (12.30)	17.52 (28.20)

C-TRAN COMPOSITE RESULTS

	HC GRAMS/KM (GRAMS/MILE)	1.84 (2.95)
	CO GRAMS/KM (GRAMS/MILE)	9.27 (14.91)
	CO2 GRAMS/KM (GRAMS/MILE)	1329.86 (2139.74)
CONTINUOUS	NOX GRAMS/KM (GRAMS/MILE)	10.09 (16.23)
	TOTAL DISTANCE KM (MILES)	8.828 (5.49)
	FUEL CONSUMPTION KG (LB)	3.764 (8.300)
	FUEL ECONOMY L/100KM (MPG)	52.51 (4.48)

PARTICULATE RATE

GRAMS/TEST	28.566
GRAMS/KG FUEL	7.59
GRAMS/KM	3.24
GRAMS/MILE	5.21
FILTER EFF.	95.35

TABLE D-32. H-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 CMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 1934
DATE 12/12/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 223346. KM(138781. MILES)

BAROMETER 733.04 MM HG(28.86 IN HG)
RELATIVE HUMIDITY 59. PCT

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 11.8 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.02

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	252.42 (8912.9)	252.34 (8910.2)	252.42 (8912.9)	252.33 (8909.8)
TOT. 20X20 RATE SCMM (SCFM)	3.17 (111.9)	3.17 (111.9)	3.17 (111.9)	3.17 (111.9)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.24)	.04 (1.24)	.04 (1.24)	.04 (1.24)
TOT FLOW STD. CU. METRES(SCF)	1082.1 (38210.)	1213.8 (42861.)	1137.5 (40166.)	1115.8 (39400.)
HC SAMPLE METER/RANGE/PPM	18.9/21/ 9.44	22.1/21/11.04	28.8/21/14.40	23.2/21/11.60
HC BCKGRD METER/RANGE/PPM	9.8/ 1/ 4.90	11.6/ 1/ 5.80	13.4/ 1/ 6.70	14.9/ 1/ 7.45
CO SAMPLE METER/RANGE/PPM	16.3/13/14.69	14.2/13/12.77	20.9/13/18.94	13.0/13/11.67
CO BCKGRD METER/RANGE/PPM	.7/13/ .62	.8/13/ .71	.9/13/ .80	.9/13/ .80
CO2 SAMPLE METER/RANGE/PCT	59.2/13/.1186	69.3/13/.1413	71.1/12/.2971	57.5/13/.1149
CO2 BCKGRD METER/RANGE/PCT	21.0/13/.0386	22.0/13/.0406	12.6/12/.0429	22.1/13/.0408
NOX SAMPLE METER/RANGE/PPM	23.5/ 1/ 6.98	27.3/ 1/ 8.11	56.6/ 1/16.83	22.6/ 1/ 6.72
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .20	.7/ 1/ .20	.9/ 1/ .26	.7/ 1/ .20
DILUTION FACTOR	110.78	93.31	44.61	114.38
HC CONCENTRATION PPM	4.58	5.30	7.85	4.21
CO CONCENTRATION PPM	13.78	11.80	17.71	10.65
CO2 CONCENTRATION PCT	.0803	.1011	.2552	.0745
NOX CONCENTRATION PPM	6.78	7.92	16.58	6.52
HC MASS GRAMS	2.860	3.711	5.149	2.710
CO MASS GRAMS	17.354	16.676	23.449	13.832
CO2 MASS GRAMS	1591.83	2247.44	5315.17	1520.97
NOX MASS GRAMS	14.326	18.748	36.792	14.189
MASS OF FUEL BURNED GRAMS	514.17	721.72	1695.31	489.89
MEASURED DISTANCE KM (MILES)	.843 (.524)	1.857 (1.154)	5.326 (3.310)	.850 (.528)
FUEL ECONOMY L/100KM (MPG)	75.12 (3.132)	47.86 (4.916)	39.20 (6.001)	70.99 (3.314)
HC GRAMS/KM (GRAMS/MILE)	3.39 (5.46)	2.00 (3.22)	.97 (1.56)	3.19 (5.13)
CO GRAMS/KM (GRAMS/MILE)	20.59 (33.13)	8.98 (14.45)	4.40 (7.08)	16.28 (26.19)
CO2 GRAMS/KM (GRAMS/MILE)	1888.5 (3038.5)	1210.1 (1947.1)	998.0 (1605.8)	1789.8 (2879.8)
NOX GRAMS/KM (GRAMS/MILE)	17.00 (27.35)	10.09 (16.24)	6.91 (11.12)	16.70 (26.87)

H-TRAN COMPOSITE RESULTS

HC GRAMS/KM (GRAMS/MILE)	1.63 (2.62)
CO GRAMS/KM (GRAMS/MILE)	8.03 (12.93)
CO2 GRAMS/KM (GRAMS/MILE)	1202.76 (1935.24)
NOX GRAMS/KM (GRAMS/MILE)	9.47 (15.24)
TOTAL DISTANCE KM (MILES)	8.876 (5.52)
FUEL CONSUMPTION KG (LB)	3.421 (7.544)
FUEL ECONOMY L/100KM (MPG)	47.47 (4.96)

PARTICULATE RATE	
GRAMS/TEST	20.606
GRAMS/KG FUEL	6.02
GRAMS/KM	2.32
GRAMS/MILE	3.74

FILTER EFF. 96.09

TABLE D-32. H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 1
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 1934
DATE 12/12/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 223346. KM(138781. MILES)

BAROMETER 733.04 MM HG(28.86 IN HG)
RELATIVE HUMIDITY 59. PCT

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 11.8 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.02

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	252.42 (8912.9)	252.34 (8910.2)	252.42 (8912.9)	252.33 (8909.8)
TOT. 20X20 RATE SCMM (SCFM)	3.17 (111.9)	3.17 (111.9)	3.17 (111.9)	3.17 (111.9)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.04 (1.24)	.04 (1.24)	.04 (1.24)	.04 (1.24)
TOT FLOW STD. CU. METRES(SCF)	1082.1 (38210.)	1213.8 (42861.)	1137.5 (40166.)	1115.8 (39400.)
HC SAMPLE METER/RANGE/PPM	18.9/21/ 9.44	22.1/21/11.04	28.8/21/14.40	23.2/21/11.60
HC BCKGRD METER/RANGE/PPM	9.8/ 1/ 4.90	11.6/ 1/ 5.80	13.4/ 1/ 6.70	14.9/ 1/ 7.45
CO SAMPLE METER/RANGE/PPM	16.3/13/14.69	14.2/13/12.77	20.9/13/18.94	13.0/13/11.67
CO BCKGRD METER/RANGE/PPM	.7/13/ .62	.8/13/ .71	.9/13/ .80	.9/13/ .80
CO2 SAMPLE METER/RANGE/PCT	59.2/13/.1186	69.3/13/.1413	71.1/12/.2971	57.5/13/.1149
CO2 BCKGRD METER/RANGE/PCT	21.0/13/.0386	22.0/13/.0406	12.6/12/.0429	22.1/13/.0408
NOX SAMPLE METER/RANGE/PPM	6.5/12/ 6.52	8.2/12/ 8.19	18.3/12/18.28	6.6/12/ 6.60
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .20	.7/ 1/ .20	.9/ 1/ .26	.7/ 1/ .20
DILUTION FACTOR	110.78	93.31	44.61	114.38
HC CONCENTRATION PPM	4.58	5.30	7.85	4.21
CO CONCENTRATION PPM	13.78	11.80	17.71	10.65
CO2 CONCENTRATION PCT	.0803	.1011	.2552	.0745
NOX CONCENTRATION PPM	6.32	7.99	18.03	6.40
HC MASS GRAMS	2.860	3.711	5.149	2.710
CO MASS GRAMS	17.354	16.676	23.449	13.832
CO2 MASS GRAMS	1591.83	2247.44	5315.17	1520.97
NOX MASS GRAMS	13.347	18.918	40.018	13.928
MASS OF FUEL BURNED GRAMS	514.17	721.72	1695.31	489.89
MEASURED DISTANCE KM (MILES)	.843 (.524)	1.857 (1.154)	5.326 (3.310)	.850 (.528)
FUEL ECONOMY L/100KM (MPG)	75.12 (3.132)	47.86 (4.916)	39.20 (6.001)	70.99 (3.314)
HC GRAMS/KM (GRAMS/MILE)	3.39 (5.46)	2.00 (3.22)	.97 (1.56)	3.19 (5.13)
CO GRAMS/KM (GRAMS/MILE)	20.59 (33.13)	8.98 (14.45)	4.40 (7.08)	16.28 (26.19)
CO2 GRAMS/KM (GRAMS/MILE)	1888.5 (3038.5)	1210.1 (1947.1)	998.0 (1605.8)	1789.8 (2879.8)
NOX GRAMS/KM (GRAMS/MILE)	15.83 (25.48)	10.19 (16.39)	7.51 (12.09)	16.39 (26.37)

H-TRAN COMPOSITE RESULTS

HC	GRAMS/KM (GRAMS/MILE)	1.63 (2.62)
CO	GRAMS/KM (GRAMS/MILE)	8.03 (12.93)
CO2	GRAMS/KM (GRAMS/MILE)	1202.76 (1935.24)
CONTINUOUS NOX	GRAMS/KM (GRAMS/MILE)	9.71 (15.63)

TOTAL DISTANCE KM (MILES)	8.876 (5.52)
FUEL CONSUMPTION KG (LB)	3.421 (7.544)
FUEL ECONOMY L/100KM (MPG)	47.47 (4.96)

PARTICULATE RATE

GRAMS/TEST	20.606
GRAMS/KG FUEL	6.02
GRAMS/KM	2.32
GRAMS/MILE	3.74

FILTER EFF. 96.09

TABLE D-33.H-TRAN VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

TEST NO. 1 RUN 2
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 1934
DATE 12/12/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 223491. KM(138871. MILES)

BAROMETER 730.76 MM HG(28.77 IN HG)
RELATIVE HUMIDITY 77. PCT

DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)
ABS. HUMIDITY 12.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.03

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	251.05 (8864.4)	250.88 (8858.5)	250.97 (8861.8)	250.90 (8859.1)
TOT. 20X20 RATE SCMM (SCFM)	3.14 (110.7)	3.14 (110.7)	3.14 (110.7)	3.14 (110.7)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.03 (.92)	.03 (.92)	.03 (.92)	.03 (.92)
TOT FLOW STD. CU. METRES(SCF)	1076.1 (37999.)	1206.7 (42608.)	1130.9 (39932.)	1109.4 (39173.)
HC SAMPLE METER/RANGE/PPM	22.5/21/11.25	23.5/21/11.77	29.7/21/14.83	23.5/21/11.76
HC BCKGRD METER/RANGE/PPM	12.1/ 1/ 6.05	13.0/ 1/ 6.50	13.8/ 1/ 6.90	13.8/ 1/ 6.90
CO SAMPLE METER/RANGE/PPM	14.0/13/12.58	14.1/13/12.68	22.1/13/20.06	15.5/13/13.96
CO BCKGRD METER/RANGE/PPM	.9/13/ .80	2.1/13/ 1.86	4.3/13/ 3.82	3.4/13/ 3.02
CO2 SAMPLE METER/RANGE/PCT	58.6/13/.1173	68.5/13/.1394	71.0/12/.2966	56.4/13/.1125
CO2 BCKGRD METER/RANGE/PCT	20.1/13/.0368	20.0/13/.0366	11.7/12/.0396	20.2/13/.0370
NOX SAMPLE METER/RANGE/PPM	23.8/ 1/ 7.07	27.8/ 1/ 8.26	56.0/ 1/16.65	22.8/ 1/ 6.77
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ .11	.5/ 1/ .14	.5/ 1/ .14	.5/ 1/ .14
DILUTION FACTOR	112.03	94.48	44.66	116.54
HC CONCENTRATION PPM	5.26	5.34	8.09	4.92
CO CONCENTRATION PPM	11.47	10.53	15.80	10.66
CO2 CONCENTRATION PCT	.0808	.1032	.2578	.0758
NOX CONCENTRATION PPM	6.96	8.12	16.51	6.64
HC MASS GRAMS	3.262	3.717	5.273	3.148
CO MASS GRAMS	14.376	14.795	20.807	13.772
CO2 MASS GRAMS	1591.56	2279.73	5338.32	1538.78
NOX MASS GRAMS	14.696	19.226	36.631	14.438
MASS OF FUEL BURNED GRAMS	513.01	730.99	1701.43	495.93
MEASURED DISTANCE KM (MILES)	.850 (.529)	1.840 (1.144)	5.346 (3.322)	.859 (.534)
FUEL ECONOMY L/100KM (MPG)	74.28 (3.167)	48.92 (4.808)	39.19 (6.002)	71.12 (3.308)
HC GRAMS/KM (GRAMS/MILE)	3.84 (6.17)	2.02 (3.25)	.99 (1.59)	3.67 (5.90)
CO GRAMS/KM (GRAMS/MILE)	16.90 (27.20)	8.04 (12.94)	3.89 (6.26)	16.04 (25.80)
CO2 GRAMS/KM (GRAMS/MILE)	1871.3 (3011.0)	1239.0 (1993.6)	998.6 (1606.7)	1791.9 (2883.2)
NOX GRAMS/KM (GRAMS/MILE)	17.28 (27.80)	10.45 (16.81)	6.85 (11.03)	16.81 (27.05)

H-TRAN COMPOSITE RESULTS

HC GRAMS/KM (GRAMS/MILE)	1.73 (2.79)
CO GRAMS/KM (GRAMS/MILE)	7.17 (11.53)
CO2 GRAMS/KM (GRAMS/MILE)	1208.36 (1944.25)
NOX GRAMS/KM (GRAMS/MILE)	9.55 (15.37)
TOTAL DISTANCE KM (MILES)	8.895 (5.53)
FUEL CONSUMPTION KG (LB)	3.441 (7.588)
FUEL ECONOMY L/100KM (MPG)	47.64 (4.94)

PARTICULATE RATE

GRAMS/TEST	19.967
GRAMS/KG FUEL	5.80
GRAMS/KM	2.24
GRAMS/MILE	3.61
FILTER EFF.	95.24

TABLE D-33. H-TRAN VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

TEST NO. 1 RUN 2
VEHICLE MODEL 1983 GMC RTSII 04
ENGINE 9.0 L(552. CID) V-6
TRANSMISSION A-3
GVW16738. KG(36900. LBS)

VEHICLE NO. 1934
DATE 12/12/84
BAG CART NO. 1
DYNO NO. 4
CVS NO. 11

TEST WEIGHT 13608. KG(30000. LBS)
ACTUAL ROAD LOAD 58.4 KW(78.3 HP)
DIESEL EM-400-F
ODOMETER 223491. KM(138871. MILES)

BAROMETER 730.76 MM HG(28.77 IN HG)
RELATIVE HUMIDITY 77. PCT

DRY BULB TEMP. 20.6 DEG C(69.0 DEG F)
ABS. HUMIDITY 12.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.03

BAG RESULTS				
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
RUN TIME SECONDS	254.0	285.0	267.0	262.0
TOT. BLOWER RATE SCMM (SCFM)	251.05 (8864.4)	250.88 (8858.5)	250.97 (8861.8)	250.90 (8859.1)
TOT. 20X20 RATE SCMM (SCFM)	3.14 (110.7)	3.14 (110.7)	3.14 (110.7)	3.14 (110.7)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	.03 (.92)	.03 (.92)	.03 (.92)	.03 (.92)
TOT FLOW STD. CU. METRES(SCF)	1076.1 (37999.)	1206.7 (42608.)	1130.9 (39932.)	1109.4 (39173.)
HC SAMPLE METER/RANGE/PPM	22.5/21/11.25	23.5/21/11.77	29.7/21/14.83	23.5/21/11.76
HC BCKGRD METER/RANGE/PPM	12.1/ 1/ 6.05	13.0/ 1/ 6.50	13.8/ 1/ 6.90	13.8/ 1/ 6.90
CO SAMPLE METER/RANGE/PPM	14.0/13/12.58	14.1/13/12.68	22.1/13/20.06	15.5/13/13.96
CO BCKGRD METER/RANGE/PPM	.9/13/ .80	2.1/13/ 1.86	4.3/13/ 3.82	3.4/13/ 3.02
CO2 SAMPLE METER/RANGE/PCT	58.6/13/.1173	68.5/13/.1394	71.0/12/.2966	56.4/13/.1125
CO2 BCKGRD METER/RANGE/PCT	20.1/13/.0368	20.0/13/.0366	11.7/12/.0396	20.2/13/.0370
NOX SAMPLE METER/RANGE/PPM	6.5/12/ 6.52	8.1/12/ 8.13	17.7/12/17.74	6.7/12/ 6.71
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ .11	.5/ 1/ .14	.5/ 1/ .14	.5/ 1/ .14
DILUTION FACTOR	112.03	94.48	44.66	116.54
HC CONCENTRATION PPM	5.26	5.34	8.09	4.92
CO CONCENTRATION PPM	11.47	10.53	15.80	10.66
CO2 CONCENTRATION PCT	.0808	.1032	.2578	.0758
NOX CONCENTRATION PPM	6.41	8.00	17.61	6.57
HC MASS GRAMS	3.262	3.717	5.273	3.148
CO MASS GRAMS	14.376	14.795	20.807	13.772
CO2 MASS GRAMS	1591.56	2279.73	5338.32	1538.78
NOX MASS GRAMS	13.529	18.924	39.053	14.287
MASS OF FUEL BURNED GRAMS	513.01	730.99	1701.43	495.93
MEASURED DISTANCE KM (MILES)	.850 (.529)	1.840 (1.144)	5.346 (3.322)	.859 (.534)
FUEL ECONOMY L/100KM (MPG)	74.28 (3.167)	48.92 (4.808)	39.19 (6.002)	71.12 (3.308)
HC GRAMS/KM (GRAMS/MILE)	3.84 (6.17)	2.02 (3.25)	.99 (1.59)	3.67 (5.90)
CO GRAMS/KM (GRAMS/MILE)	16.90 (27.20)	8.04 (12.94)	3.89 (6.26)	16.04 (25.80)
CO2 GRAMS/KM (GRAMS/MILE)	1871.3 (3011.0)	1239.0 (1993.6)	998.6 (1606.7)	1791.9 (2883.2)
NOX GRAMS/KM (GRAMS/MILE)	15.91 (25.60)	10.28 (16.55)	7.31 (11.75)	16.64 (26.77)

H-TRAN COMPOSITE RESULTS

HC	GRAMS/KM (GRAMS/MILE)	1.73 (2.79)
CO	GRAMS/KM (GRAMS/MILE)	7.17 (11.53)
CO2	GRAMS/KM (GRAMS/MILE)	1208.36 (1944.25)
CONTINUOUS NOX	GRAMS/KM (GRAMS/MILE)	9.64 (15.52)

TOTAL DISTANCE KM (MILES)	8.895 (5.53)
FUEL CONSUMPTION KG (LB)	3.441 (7.588)
FUEL ECONOMY L/100KM (MPG)	47.64 (4.94)

PARTICULATE RATE	
GRAMS/TEST	19.967
GRAMS/KG FUEL	5.80
GRAMS/KM	2.24
GRAMS/MILE	3.61

FILTER EFF. 95.24

TABLE D-34. BUS F VEHICLE EMISSIONS RESULTS
PROJECT 03-5428-001

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TEST NO.   1        RUN   1               VEHICLE NO. 1934                          TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04           DATE    12/12/84                          ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6              BAG CART NO.  1                           DIESEL     EM-400-F
TRANSMISSION A-3                          DYNO NO.      4                           ODOMETER 223346. KM(138781. MILES)
GVW16738. KG(36900. LBS)                  CVS NO.      11

BAROMETER 732.28 MM HG(28.83 IN HG)       DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)
RELATIVE HUMIDITY  73. PCT                ABS. HUMIDITY 12.3 GM/KG                  NOX HUMIDITY CORRECTION FACTOR  1.03

BAG RESULTS
   TEST CYCLE                                  BUS F

   RUN TIME               SECONDS              1193.5
   TOT. BLOWER RATE SCMM (SCFM)           169.16 ( 5973.2)
   TOT. 20X20 RATE SCMM (SCFM)              3.14 (111.0)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)         .03 ( 1.23)
   TOT FLOW STD. CU. METRES(SCF)          3428.2 (121049.)

   HC  SAMPLE METER/RANGE/PPM              29.8/21/14.92
   HC  BCKGRD METER/RANGE/PPM              15.4/ 1/ 7.70
   CO  SAMPLE METER/RANGE/PPM               8.7/13/ 7.77
   CO  BCKGRD METER/RANGE/PPM                .5/13/  .44
   CO2 SAMPLE METER/RANGE/PCT              68.3/13/.1390
   CO2 BCKGRD METER/RANGE/PCT              24.4/13/.0453
   NOX SAMPLE METER/RANGE/PPM              30.2/ 1/ 8.98
   NOX BCKGRD METER/RANGE/PPM                .7/ 1/  .20
   DILUTION FACTOR                             94.89

   HC  CONCENTRATION PPM                        7.31
   CO  CONCENTRATION PPM                        7.14
   CO2 CONCENTRATION PCT                       .0941
   NOX CONCENTRATION PPM                        8.78
   HC  MASS GRAMS                              14.442
   CO  MASS GRAMS                              28.498
   CO2 MASS GRAMS                            5905.89
   NOX MASS GRAMS                              59.257
   MASS OF FUEL BURNED GRAMS                 1893.65
   MEASURED DISTANCE  KM (MILES)            4.594 (2.855)
   FUEL ECONOMY  L/100KM (MPG)              50.76 ( 4.635)

   HC   GRAMS/KM (GRAMS/MILE)                3.14 (  5.06)
   CO   GRAMS/KM (GRAMS/MILE)                6.20 (  9.98)
   CO2  GRAMS/KM (GRAMS/MILE)              1285.4 (2068.3)
   NOX  GRAMS/KM (GRAMS/MILE)               12.90 ( 20.75)

                                          BUS F  COMPOSITE RESULTS
              HC   GRAMS/KM (GRAMS/MILE)     3.14 ( 5.06)                         PARTICULATE RATE
              CO   GRAMS/KM (GRAMS/MILE)     6.20 (  9.98)                        GRAMS/TEST        9.784
              CO2  GRAMS/KM (GRAMS/MILE)  1285.45 (2068.29)                       GRAMS/KG FUEL     5.17
              NOX  GRAMS/KM (GRAMS/MILE)    12.90 (20.75)                         GRAMS/KM          2.13
                                                                                  GRAMS/MILE        3.43


              TOTAL DISTANCE  KM (MILES)     4.594 ( 2.86)                        FILTER EFF.      94.15
              FUEL CONSUMPTION  KG (LB)      1.894 ( 4.176)
              FUEL ECONOMY  L/100KM (MPG)    50.76 ( 4.63)
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TABLE D-34.BUS F VEHICLE EMISSIONS RESULTS (Cont'd)

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                                        PROJECT 03-5428-001

TEST NO.   1       RUN   1              VEHICLE NO. 1934                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04          'TE   12/12/84                  ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6            BAG CART NO.  1                  DIESEL     EM-400-F
TRANSMISSION A-3                        DYNO NO.      4                  ODOMETER 223346. KM(138781. MILES)
GVW16738. KG(36900. LBS)                CVS NO.      11

BAROMETER 732.28 MM HG(28.83 IN HG)     DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR  1.03
RELATIVE HUMIDITY  73. PCT              ABS. HUMIDITY 12.3 GM/KG

BAG RESULTS
  TEST CYCLE                                   BUS F

  RUN TIME                   SECONDS          1193.5
  TOT. BLOWER RATE SCMM (SCFM)           169.16 ( 5973.2)
  TOT. 20X20 RATE SCMM (SCFM)              3.14 (111.0)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)         .03 ( 1.23)
  TOT FLOW STD. CU. METRES(SCF)          3428.2 (121049.)

  HC  SAMPLE METER/RANGE/PPM              29.8/21/14.92
  HC  BCKGRD METER/RANGE/PPM              15.4/ 1/ 7.70
  CO  SAMPLE METER/RANGE/PPM               8.7/13/ 7.77
  CO  BCKGRD METER/RANGE/PPM                .5/13/  .44
  CO2 SAMPLE METER/RANGE/PCT              68.3/13/.1390
  CO2 BCKGRD METER/RANGE/PCT              24.4/13/.0453
  NOX SAMPLE METER/RANGE/PPM               9.0/12/ 9.02
  NOX BCKGRD METER/RANGE/PPM                .7/ 1/  .20
  DILUTION FACTOR                              94.89

  HC  CONCENTRATION PPM                         7.31
  CO  CONCENTRATION PPM                         7.14
  CO2 CONCENTRATION PCT                        .0941
  NOX CONCENTRATION PPM                         8.83
  HC  MASS GRAMS                               14.442
  CO  MASS GRAMS                               28.498
  CO2 MASS GRAMS                             5905.89
  NOX MASS GRAMS                               59.584
  MASS OF FUEL BURNED GRAMS                  1893.65
  MEASURED DISTANCE  KM (MILES)            4.594 (2.855)
  FUEL ECONOMY  L/100KM (MPG)              50.76 ( 4.635)

  HC   GRAMS/KM (GRAMS/MILE)                3.14 (  5.06)
  CO   GRAMS/KM (GRAMS/MILE)                6.20 (  9.98)
  CO2  GRAMS/KM (GRAMS/MILE)              1285.4 (2068.3)
  NOX  GRAMS/KM (GRAMS/MILE)               12.97 ( 20.87)

                                          BUS F  COMPOSITE RESULTS             PARTICULATE RATE
                HC   GRAMS/KM (GRAMS/MILE)     3.14 ( 5.06)                    GRAMS/TEST      9.784
                CO   GRAMS/KM (GRAMS/MILE)     6.20 (  9.98)                   GRAMS/KG FUEL   5.17
                CO2  GRAMS/KM (GRAMS/MILE)  1285.45 (2068.29)                  GRAMS/KM        2.13
    CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)    12.97 (20.87)                    GRAMS/MILE      3.43


                TOTAL DISTANCE  KM (MILES)      4.594 ( 2.86)                  FILTER EFF.     94.15
                FUEL CONSUMPTION  KG (LB)       1.894 ( 4.176)
                FUEL ECONOMY  L/100KM (MPG)     50.76 ( 4.63)
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TABLE D-35.BUS UN VEHICLE EMISSIONS RESULTS

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                                        PROJECT 03-5428-001
                                                                            TEST WEIGHT 13608. KG(30000. LBS)
                                               VEHICLE NO. 1934             ^TUAL ROAD LOAD  58.4 KW( 78.3 HP)
TEST NO.    1         RUN   1                  DATE    12/12/84             DIESEL     EM-400-F
VEHICLE MODEL 1983 GMC RTSII 04                BAG CART NO.  1              ODOMETER 223346. KM(138781. MILES)
ENGINE  9.0 L( 552. CID) V-6                   DYNO NO.      4
TRANSMISSION A-3                               CVS NO.      11
GVW16738. KG(36900. LBS)
                                               DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.03
BAROMETER 731.77 MM HG(28.81 IN HG)            ABS. HUMIDITY 12.1 GM/KG
RELATIVE HUMIDITY  69. PCT

BAG RESULTS                                      BUS UN
  TEST CYCLE
                                                  1196.1
  RUN TIME                  SECONDS            168.63 ( 5954.2)
  TOT. BLOWER RATE SCMM (SCFM)                   3.14 (111.0)
  TOT. 20X20 RATE SCMM (SCFM)                     .03 (   .92)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            3424.8 (120929.)
  TOT FLOW STD. CU. METRES(SCF)
                                                25.4/21/12.71
  HC  SAMPLE METER/RANGE/PPM                    11.8/ 1/ 5.90
  HC  BCKGRD METER/RANGE/PPM                    21.6/13/19.59
  CO  SAMPLE METER/RANGE/PPM                      .3/13/  .27
  CO  BCKGRD METER/RANGE/PPM                    75.0/13/.1546
  CO2 SAMPLE METER/RANGE/PCT                    21.7/13/.0400
  CO2 BCKGRD METER/RANGE/PCT                    31.6/ 1/ 9.39
  NOX SAMPLE METER/RANGE/PPM                      .4/ 1/  .11
  NOX BCKGRD METER/RANGE/PPM                       84.93
  DILUTION FACTOR
                                                    6.88
  HC  CONCENTRATION PPM                            18.84
  CO  CONCENTRATION PPM                            .1151
  CO2 CONCENTRATION PCT                             9.28
  NOX CONCENTRATION PPM                            13.592
  HC  MASS GRAMS                                   75.120
  CO  MASS GRAMS                                  7217.62
  CO2 MASS GRAMS                                   62.332
  NOX MASS GRAMS                                  2330.18
  MASS OF FUEL BURNED GRAMS                     4.710 (2.927)
  MEASURED DISTANCE  KM (MILES)                 60.92 ( 3.861)
  FUEL ECONOMY  L/100KM (MPG)
                                                 2.89 (  4.64)
  HC   GRAMS/KM (GRAMS/MILE)                    15.95 ( 25.66)
  CO   GRAMS/KM (GRAMS/MILE)                   1532.4 (2465.6)
  CO2  GRAMS/KM (GRAMS/MILE)                    13.23 ( 21.29)
  NOX  GRAMS/KM (GRAMS/MILE)

                                                  BUS UN COMPOSITE RESULTS             PARTICULATE RATE
                 HC   GRAMS/KM (GRAMS/MILE)        2.89 ( 4.64)                         GRAMS/TEST      18.435
                 CO   GRAMS/KM (GRAMS/MILE)       15.95 ( 25.66)                        GRAMS/KG FUEL    7.91
                 CO2  GRAMS/KM (GRAMS/MILE)     1532.40 (2465.62)                       GRAMS/KM         3.91
                 NOX  GRAMS/KM (GRAMS/MILE)       13.23 (21.29)                         GRAMS/MILE       6.30


                 TOTAL DISTANCE  KM (MILES)       4.710 ( 2.93)                         FILTER EFF.     97.41
                 FUEL CONSUMPTION  KG (LB)        2.330 ( 5.138)
                 FUEL ECONOMY  L/100KM (MPG)      60.92 ( 3.86)
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TABLE D-35.

```
                                   BUS UN VEHICLE EMISSIONS RESULTS   (Cont'd)
                                          PROJECT 03-5428-001

                                          VEHICLE NO. 1934                         TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   1        RUN   1               DATE   12/12/84                          ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04           BAG CART NO.  1                          DIESEL    EM-400-F
ENGINE  9.0 L( 552. CID) V-6              DYNO NO.      4                          ODOMETER 223346. KM(138781. MILES)
TRANSMISSION A-3                          CVS NO.      11
GVW16738. KG(36900. LBS)
                                          DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.03
BAROMETER 731.77 MM HG(28.81 IN HG)       ABS. HUMIDITY 12.1 GM/KG
RELATIVE HUMIDITY  69. PCT

BAG RESULTS                                    BUS UN
   TEST CYCLE

   RUN TIME                  SECONDS          1196.1
   TOT. BLOWER RATE SCMM (SCFM)             168.63 ( 5954.2)
   TOT. 20X20 RATE SCMM (SCFM)                3.14 (111.0)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)           .03 (   .92)
   TOT FLOW STD. CU. METRES(SCF)           3424.8 (120929.)

   HC   SAMPLE METER/RANGE/PPM               25.4/21/12.71
   HC   BCKGRD METER/RANGE/PPM               11.8/ 1/ 5.90
   CO   SAMPLE METER/RANGE/PPM               21.6/13/19.59
   CO   BCKGRD METER/RANGE/PPM                 .3/13/  .27
   CO2  SAMPLE METER/RANGE/PCT               75.0/13/.1546
   CO2  BCKGRD METER/RANGE/PCT               21.7/13/.0400
   NOX  SAMPLE METER/RANGE/PPM                9.7/12/ 9.66
   NOX  BCKGRD METER/RANGE/PPM                 .4/ 1/  .11
   DILUTION FACTOR                             84.93

   HC   CONCENTRATION PPM                       6.88
   CO   CONCENTRATION PPM                      18.84
   CO2  CONCENTRATION PCT                      .1151
   NOX  CONCENTRATION PPM                       9.55
   HC   MASS GRAMS                             13.592
   CO   MASS GRAMS                             75.120
   CO2  MASS GRAMS                           7217.62
   NOX  MASS GRAMS                             64.095
   MASS OF FUEL BURNED GRAMS                 2330.18
   MEASURED DISTANCE  KM (MILES)             4.710 (2.927)
   FUEL ECONOMY  L/100KM (MPG)               60.92 ( 3.861)

   HC   GRAMS/KM (GRAMS/MILE)                  2.89 (  4.64)
   CO   GRAMS/KM (GRAMS/MILE)                 15.95 ( 25.66)
   CO2  GRAMS/KM (GRAMS/MILE)               1532.4 (2465.6)
   NOX  GRAMS/KM (GRAMS/MILE)                 13.61 ( 21.90)

                                          BUS UN COMPOSITE RESULTS              PARTICULATE RATE
                 HC   GRAMS/KM (GRAMS/MILE)      2.89 ( 4.64)                   GRAMS/TEST       18.435
                 CO   GRAMS/KM (GRAMS/MILE)     15.95 ( 25.66)                  GRAMS/KG FUEL     7.91
                 CO2  GRAMS/KM (GRAMS/MILE)   1532.40 (2465.62)                 GRAMS/KM          3.91
      CONTINUOUS NOX  GRAMS/KM (GRAMS/MILE)     13.61 (21.90)                   GRAMS/MILE        6.30

                 TOTAL DISTANCE  KM (MILES)      4.710 ( 2.93)                  FILTER EFF.      97.41
                 FUEL CONSUMPTION  KG (LB)       2.330 ( 5.138)
                 FUEL ECONOMY  L/100KM (MPG)    60.92 ( 3.86)
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TABLE D-36.

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                                CBD    VEHICLE EMISSIONS RESULTS
                                        PROJECT 03-5428-001

TEST NO.    1        RUN   1                     VEHICLE NO. 1934              TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                  DATE    12/12/84              ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                     BAG CART NO.  1               DIESEL     EM-400-F
TRANSMISSION A-3                                 DYNO NO.      4               ODOMETER 223491. KM(138871. MILES)
GVW16738. KG(36900. LBS)                         CVS NO.      11

BAROMETER 731.52 MM HG(28.80 IN HG)              DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.03
RELATIVE HUMIDITY  73. PCT                       ABS. HUMIDITY 12.3 GM/KG

BAG RESULTS                                          CBD
  TEST CYCLE

  RUN TIME                 SECONDS                 582.4
  TOT. BLOWER RATE SCMM (SCFM)                 168.77 ( 5959.1)
  TOT. 20X20 RATE SCMM (SCFM)                    3.13 (110.4)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)               .03 (  .96)
  TOT FLOW STD. CU. METRES(SCF)                1668.8 ( 58924.)

  HC   SAMPLE METER/RANGE/PPM                   28.2/21/14.09
  HC   BCKGRD METER/RANGE/PPM                   11.1/ 1/ 5.55
  CO   SAMPLE METER/RANGE/PPM                   34.0/13/31.32
  CO   BCKGRD METER/RANGE/PPM                     .3/13/  .27
  CO2  SAMPLE METER/RANGE/PCT                   98.7/13/.2191
  CO2  BCKGRD METER/RANGE/PCT                   21.0/13/.0386
  NOX  SAMPLE METER/RANGE/PPM                   47.6/ 1/14.15
  NOX  BCKGRD METER/RANGE/PPM                     .4/ 1/  .11
  DILUTION FACTOR                                   59.94

  HC   CONCENTRATION PPM                             8.64
  CO   CONCENTRATION PPM                            30.19
  CO2  CONCENTRATION PCT                            .1812
  NOX  CONCENTRATION PPM                            14.04
  HC   MASS GRAMS                                   8.310
  CO   MASS GRAMS                                  58.656
  CO2  MASS GRAMS                                 5535.34
  NOX  MASS GRAMS                                  46.160
  MASS OF FUEL BURNED GRAMS                       1785.47
  MEASURED DISTANCE  KM (MILES)                 3.299 (2.050)
  FUEL ECONOMY   L/100KM (MPG)                  66.65 ( 3.529)

  HC    GRAMS/KM (GRAMS/MILE)                     2.52 (  4.05)
  CO    GRAMS/KM (GRAMS/MILE)                    17.78 ( 28.61)
  CO2   GRAMS/KM (GRAMS/MILE)                   1678.0 (2699.9)
  NOX   GRAMS/KM (GRAMS/MILE)                    13.99 ( 22.52)

                                            CBD    COMPOSITE RESULTS          PARTICULATE RATE
         HC   GRAMS/KM (GRAMS/MILE)        2.52 ( 4.05)                       GRAMS/TEST        12.931
         CO   GRAMS/KM (GRAMS/MILE)       17.78 ( 28.61)                      GRAMS/KG FUEL      7.24
         CO2  GRAMS/KM (GRAMS/MILE)     1678.02 (2699.93)                     GRAMS/KM           3.92
         NOX  GRAMS/KM (GRAMS/MILE)       13.99 (22.52)                       GRAMS/MILE         6.31


         TOTAL DISTANCE  KM (MILES)       3.299 ( 2.05)                       FILTER EFF.      96.61
         FUEL CONSUMPTION  KG (LB)        1.785 ( 3.937)
         FUEL ECONOMY   L/100KM (MPG)     66.65 ( 3.53)
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TABLE D-36. CBD VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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                                                    VEHICLE NO. 1934                   TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.    1         RUN    1                      DATE    12/12/84                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                     BAG CART NO.  1                    DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                        DYNO NO.       4                   ODOMETER 223491. KM(138871. MILES)
TRANSMISSION A-3                                    CVS NO.       11
GVW16738. KG(36900. LBS)
                                                    DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.03
BAROMETER 731.52 MM HG(28.80 IN HG)                 ABS. HUMIDITY 12.3 GM/KG
RELATIVE HUMIDITY  73. PCT

BAG RESULTS                                          CBD
  TEST CYCLE
                                                    582.4
  RUN TIME                SECONDS                168.77 ( 5959.1)
  TOT. BLOWER RATE SCMM (SCFM)                     3.13 (110.4)
  TOT. 20X20 RATE SCMM (SCFM)                       .03 (   .96)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)              1668.8 ( 58924.)
  TOT FLOW STD. CU. METRES(SCF)
                                                 28.2/21/14.09
  HC  SAMPLE METER/RANGE/PPM                     11.1/ 1/ 5.55
  HC  BCKGRD METER/RANGE/PPM                     34.0/13/31.32
  CO  SAMPLE METER/RANGE/PPM                       .3/13/  .27
  CO  BCKGRD METER/RANGE/PPM                     98.7/13/.2191
  CO2 SAMPLE METER/RANGE/PCT                     21.0/13/.0386
  CO2 BCKGRD METER/RANGE/PCT                     14.6/12/14.64
  NOX SAMPLE METER/RANGE/PPM                       .4/ 1/  .11
  NOX BCKGRD METER/RANGE/PPM                        59.94
  DILUTION FACTOR
                                                     8.64
  HC  CONCENTRATION PPM                             30.19
  CO  CONCENTRATION PPM                             .1812
  CO2 CONCENTRATION PCT                             14.53
  NOX CONCENTRATION PPM                             8.310
  HC  MASS GRAMS                                   58.656
  CO  MASS GRAMS                                  5535.34
  CO2 MASS GRAMS                                   47.753
  NOX MASS GRAMS                                  1785.47
  MASS OF FUEL BURNED GRAMS                     3.299 (2.050)
  MEASURED DISTANCE  KM (MILES)                 66.65 ( 3.529)
  FUEL ECONOMY  L/100KM (MPG)
                                                 2.52 (  4.05)
  HC   GRAMS/KM (GRAMS/MILE)                    17.78 ( 28.61)
  CO   GRAMS/KM (GRAMS/MILE)                   1678.0 (2699.9)
  CO2  GRAMS/KM (GRAMS/MILE)                    14.48 ( 23.29)
  NOX  GRAMS/KM (GRAMS/MILE)

                                                 CBD    COMPOSITE RESULTS             PARTICULATE RATE
                HC   GRAMS/KM (GRAMS/MILE)       2.52 ( 4.05)                         GRAMS/TEST      12.931
                CO   GRAMS/KM (GRAMS/MILE)      17.78 ( 28.61)                        GRAMS/KG FUEL    7.24
                CO2  GRAMS/KM (GRAMS/MILE)    1678.02 (2699.93)                       GRAMS/KM         3.92
   CONTINUOUS   NOX  GRAMS/KM (GRAMS/MILE)      14.48 (23.29)                         GRAMS/MILE       6.31


                TOTAL DISTANCE  KM (MILES)      3.299 ( 2.05)                         FILTER EFF.     96.61
                FUEL CONSUMPTION  KG (LB)       1.785 ( 3.937)
                FUEL ECONOMY  L/100KM (MPG)     66.65 ( 3.53)
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                    TABLE D-37.  IDLE   VEHICLE EMISSIONS RESULTS
                                         PROJECT 03-5428-001

                                                                              TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.    1       RUN   1                    VEHICLE NO. 1934               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    12/12/84               DIESEL     EM-400-F
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                ODOMETER 223491. KM(138871. MILES)
TRANSMISSION A-3                               DYNO NO.      4
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 731.01 MM HG(28.78 IN HG)            DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.07
RELATIVE HUMIDITY  78. PCT                     ABS. HUMIDITY 14.1 GM/KG

BAG RESULTS
  TEST CYCLE                                      IDLE

  RUN TIME                  SECONDS               900.1
  TOT. BLOWER RATE SCMM (SCFM)                84.85 ( 2995.9)
  TOT. 20X20 RATE SCMM (SCFM)                  3.13 (110.6)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)             .03 (   .93)
  TOT FLOW STD. CU. METRES(SCF)              1320.2 ( 46617.)

  HC   SAMPLE METER/RANGE/PPM                 38.3/21/19.16
  HC   BCKGRD METER/RANGE/PPM                 12.6/ 1/ 6.30
  CO   SAMPLE METER/RANGE/PPM                  6.3/13/ 5.61
  CO   BCKGRD METER/RANGE/PPM                   .7/13/  .62
  CO2  SAMPLE METER/RANGE/PCT                 69.3/13/.1413
  CO2  BCKGRD METER/RANGE/PCT                 21.3/13/.0392
  NOX  SAMPLE METER/RANGE/PPM                 45.5/ 1/13.53
  NOX  BCKGRD METER/RANGE/PPM                   .3/ 1/  .08
  DILUTION FACTOR                                 93.24

  HC   CONCENTRATION PPM                          12.93
  CO   CONCENTRATION PPM                           4.86
  CO2  CONCENTRATION PCT                           .1025
  NOX  CONCENTRATION PPM                          13.45
  HC   MASS GRAMS                                  9.840
  CO   MASS GRAMS                                  7.467
  CO2  MASS GRAMS                               2477.54
  NOX  MASS GRAMS                                 36.183
  MASS OF FUEL BURNED GRAMS                      795.95
  MEASURED DISTANCE  KM (MILES)                 .001 ( .000)
  FUEL ECONOMY  L/100KM (MPG)                ****** (  .002)

  HC    GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO    GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO2   GRAMS/KM (GRAMS/MILE)                ****** (******)
  NOX   GRAMS/KM (GRAMS/MILE)                 ***** (******)


                                                IDLE   COMPOSITE RESULTS
                                                                               PARTICULATE RATE
             HC    GRAMS/KM (GRAMS/MILE)       ***** (*****)                    GRAMS/TEST        1.963
             CO    GRAMS/KM (GRAMS/MILE)      ****** (******)                   GRAMS/KG FUEL     2.47
             CO2   GRAMS/KM (GRAMS/MILE)     ******* (*******)                  GRAMS/KM        ******
             NOX   GRAMS/KM (GRAMS/MILE)       ***** (*****)                    GRAMS/MILE      ******


             TOTAL DISTANCE  KM (MILES)        .001 (  .00)                     FILTER EFF.     91.02
             FUEL CONSUMPTION  KG (LB)         .796 ( 1.755)
             FUEL ECONOMY  L/100KM (MPG)     ****** (  .00)
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TABLE D-37. IDLE   VEHICLE EMISSIONS RESULTS (Cont'd)

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                                    VEHICLE EMISSIONS RESULTS
                                     PROJECT 03-5428-001

TEST NO.    1         RUN    1                 VEHICLE NO. 1934                 TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04                DATE    12/12/84                 ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                   BAG CART NO.  1                  DIESEL     EM-400-F
TRANSMISSION A-3                               DYNO NO.      4                  ODOMETER 223491. KM(138871. MILES)
GVW16738. KG(36900. LBS)                       CVS NO.      11

BAROMETER 731.01 MM HG(28.78 IN HG)            DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
RELATIVE HUMIDITY  78. PCT                     ABS. HUMIDITY 14.1 GM/KG         NOX HUMIDITY CORRECTION FACTOR  1.07

BAG RESULTS
  TEST CYCLE                                      IDLE

  RUN TIME              SECONDS                  900.1
  TOT. BLOWER RATE SCMM (SCFM)               84.85 ( 2995.9)
  TOT. 20X20 RATE SCMM (SCFM)                 3.13 (110.6)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)            .03 (  .93)
  TOT FLOW STD. CU. METRES(SCF)             1320.2 ( 46617.)

  HC  SAMPLE METER/RANGE/PPM                 38.3/21/19.16
  HC  BCKGRD METER/RANGE/PPM                 12.6/ 1/ 6.30
  CO  SAMPLE METER/RANGE/PPM                  6.3/13/ 5.61
  CO  BCKGRD METER/RANGE/PPM                   .7/13/  .62
  CO2 SAMPLE METER/RANGE/PCT                 69.3/13/.1413
  CO2 BCKGRD METER/RANGE/PCT                 21.3/13/.0392
  NOX SAMPLE METER/RANGE/PPM                 14.2/12/14.16
  NOX BCKGRD METER/RANGE/PPM                   .3/ 1/  .08
  DILUTION FACTOR                                93.24

  HC  CONCENTRATION PPM                          12.93
  CO  CONCENTRATION PPM                           4.86
  CO2 CONCENTRATION PCT                          .1025
  NOX CONCENTRATION PPM                          14.08
  HC  MASS GRAMS                                  9.840
  CO  MASS GRAMS                                  7.467
  CO2 MASS GRAMS                               2477.54
  NOX MASS GRAMS                                 37.879
  MASS OF FUEL BURNED GRAMS                      795.95
  MEASURED DISTANCE  KM (MILES)                .001 ( .000)
  FUEL ECONOMY  L/100KM (MPG)               ****** (  .002)

  HC   GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO   GRAMS/KM (GRAMS/MILE)                ****** (******)
  CO2  GRAMS/KM (GRAMS/MILE)                ****** (******)
  NOX  GRAMS/KM (GRAMS/MILE)                 ***** (******)

                                                   IDLE   COMPOSITE RESULTS
                 HC   GRAMS/KM (GRAMS/MILE)       ***** (*****)               PARTICULATE RATE
                 CO   GRAMS/KM (GRAMS/MILE)      ****** (******)              GRAMS/TEST        1.963
                 CO2  GRAMS/KM (GRAMS/MILE)     ******* (*******)             GRAMS/KG FUEL     2.47
     CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)       ***** (*****)               GRAMS/KM        ******
                                                                              GRAMS/MILE      ******


                 TOTAL DISTANCE  KM (MILES)        .001 (  .00)               FILTER EFF.     91.02
                 FUEL CONSUMPTION  KG (LB)         .796 ( 1.755)
                 FUEL ECONOMY  L/100KM (MPG)     ****** (  .00)
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TABLE D-38. 12.5SS VEHICLE EMISSIONS RESULTS

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                                          PROJECT 03-5428-001

                                                                              TEST WEIGHT 13608. KG(30000. LBS)
TEST NO.   1      RUN   1                  VEHICLE NO. 1934                   ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
VEHICLE MODEL 1983 GMC RTSII 04            DATE   12/12/84                    DIESEL    EM-400-F
ENGINE  9.0 L( 552. CID) V-6               BAG CART NO.  1                    ODOMETER 223491. KM(138871. MILES)
TRANSMISSION A-3                           DYNO NO.      4
GVW16738. KG(36900. LBS)                   CVS NO.      11

BAROMETER 730.76 MM HG(28.77 IN HG)        DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR  1.03
RELATIVE HUMIDITY  69. PCT                 ABS. HUMIDITY 12.1 GM/KG

BAG RESULTS                                     12.5SS
  TEST CYCLE

  RUN TIME                  SECONDS            900.0
  TOT. BLOWER RATE SCMM (SCFM)              84.65 ( 2989.0)
  TOT. 20X20 RATE SCMM (SCFM)                3.12 (110.2)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)           .03 (   .93)
  TOT FLOW STD. CU. METRES(SCF)            1317.0 ( 46503.)

  HC  SAMPLE METER/RANGE/PPM                48.0/21/24.00
  HC  BCKGRD METER/RANGE/PPM                13.8/ 1/ 6.90
  CO  SAMPLE METER/RANGE/PPM                13.1/13/11.76
  CO  BCKGRD METER/RANGE/PPM                  .6/13/  .53
  CO2 SAMPLE METER/RANGE/PCT                56.1/12/.2229
  CO2 BCKGRD METER/RANGE/PCT                11.7/12/.0396
  NOX SAMPLE METER/RANGE/PPM                61.2/ 1/18.20
  NOX BCKGRD METER/RANGE/PPM                  .5/ 1/  .14
  DILUTION FACTOR                              59.17

  HC  CONCENTRATION PPM                        17.22
  CO  CONCENTRATION PPM                        10.94
  CO2 CONCENTRATION PCT                        .1840
  NOX CONCENTRATION PPM                        18.06
  HC  MASS GRAMS                               13.074
  CO  MASS GRAMS                               16.773
  CO2 MASS GRAMS                             4435.35
  NOX MASS GRAMS                               46.649
  MASS OF FUEL BURNED GRAMS                  1422.07
  MEASURED DISTANCE  KM (MILES)             5.131 (3.189)
  FUEL ECONOMY  L/100KM (MPG)              34.13 ( 6.893)

  HC   GRAMS/KM (GRAMS/MILE)                 2.55 (  4.10)
  CO   GRAMS/KM (GRAMS/MILE)                 3.27 (  5.26)
  CO2  GRAMS/KM (GRAMS/MILE)                864.4 (1390.8)
  NOX  GRAMS/KM (GRAMS/MILE)                 9.09 ( 14.63)

                                          12.5SS COMPOSITE RESULTS           PARTICULATE RATE
               HC   GRAMS/KM (GRAMS/MILE)   2.55 ( 4.10)                     GRAMS/TEST       5.369
               CO   GRAMS/KM (GRAMS/MILE)   3.27 (  5.26)                    GRAMS/KG FUEL    3.78
               CO2  GRAMS/KM (GRAMS/MILE)  864.40 (1390.82)                  GRAMS/KM         1.05
               NOX  GRAMS/KM (GRAMS/MILE)   9.09 (14.63)                     GRAMS/MILE       1.68


               TOTAL DISTANCE  KM (MILES)       5.131 ( 3.19)                FILTER EFF.     95.27
               FUEL CONSUMPTION  KG (LB)        1.422 ( 3.136)
               FUEL ECONOMY  L/100KM (MPG)     34.13 ( 6.89)
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TABLE D-38.12.5SS VEHICLE EMISSIONS RESULTS (Cont'd)

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                                PROJECT 03-5428-001

TEST NO.    1        RUN    1          VEHICLE NO. 1934               TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04        DATE    12/12/84               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6           BAG CART NO.  1                DIESEL    EM-400-F
TRANSMISSION A-3                       DYNO NO.      4                ODOMETER 223491. KM(138871. MILES)
GVW16738. KG(36900. LBS)               CVS NO.      11

BAROMETER 730.76 MM HG(28.77 IN HG)    DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)   NOX HUMIDITY CORRECTION FACTOR  1.03
RELATIVE HUMIDITY  69. PCT             ABS. HUMIDITY 12.1 GM/KG

BAG RESULTS
   TEST CYCLE                                12.5SS

   RUN TIME                 SECONDS          900.0
   TOT. BLOWER RATE SCMM (SCFM)         84.65 ( 2989.0)
   TOT. 20X20 RATE SCMM (SCFM)           3.12 (110.2)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)      .03 (   .93)
   TOT FLOW STD. CU. METRES(SCF)       1317.0 ( 46503.)

   HC   SAMPLE METER/RANGE/PPM           48.0/21/24.00
   HC   BCKGRD METER/RANGE/PPM           13.8/ 1/ 6.90
   CO   SAMPLE METER/RANGE/PPM           13.1/13/11.76
   CO   BCKGRD METER/RANGE/PPM             .6/13/  .53
   CO2  SAMPLE METER/RANGE/PCT           56.1/12/.2229
   CO2  BCKGRD METER/RANGE/PCT           11.7/12/.0396
   NOX  SAMPLE METER/RANGE/PPM           20.1/12/20.10
   NOX  BCKGRD METER/RANGE/PPM             .5/ 1/  .14
   DILUTION FACTOR                          59.17

   HC   CONCENTRATION PPM                   17.22
   CO   CONCENTRATION PPM                   10.94
   CO2  CONCENTRATION PCT                   .1840
   NOX  CONCENTRATION PPM                   19.96
   HC   MASS GRAMS                          13.074
   CO   MASS GRAMS                          16.773
   CO2  MASS GRAMS                        4435.35
   NOX  MASS GRAMS                          51.550
   MASS OF FUEL BURNED GRAMS              1422.07
   MEASURED DISTANCE  KM (MILES)         5.131 (3.189)
   FUEL ECONOMY  L/100KM (MPG)           34.13 ( 6.893)

   HC    GRAMS/KM (GRAMS/MILE)            2.55 (   4.10)
   CO    GRAMS/KM (GRAMS/MILE)            3.27 (   5.26)
   CO2   GRAMS/KM (GRAMS/MILE)           864.4 (1390.8)
   NOX   GRAMS/KM (GRAMS/MILE)           10.05 (  16.16)

                                         12.5SS COMPOSITE RESULTS         PARTICULATE RATE
                  HC   GRAMS/KM (GRAMS/MILE)     2.55 ( 4.10)             GRAMS/TEST        5.369
                  CO   GRAMS/KM (GRAMS/MILE)     3.27 (  5.26)            GRAMS/KG FUEL     3.78
                  CO2  GRAMS/KM (GRAMS/MILE)   864.40 (1390.82)           GRAMS/KM          1.05
      CONTINUOUS  NOX  GRAMS/KM (GRAMS/MILE)    10.05 (16.16)             GRAMS/MILE        1.68


                  TOTAL DISTANCE  KM (MILES)       5.131 ( 3.19)          FILTER EFF.      95.27
                  FUEL CONSUMPTION  KG (LB)        1.422 ( 3.136)
                  FUEL ECONOMY  L/100KM (MPG)      34.13 ( 6.89)
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                    TABLE D-39.25 SS  VEHICLE EMISSIONS RESULTS
                                        PROJECT 03-5428-001

TEST NO.   1          RUN   1                VEHICLE NO. 1934               TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE    12/12/84               ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                DIESEL    EM-400-F
TRANSMISSION A-3                             DYNO NO.      4                ODOMETER 223491. KM(138871. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.      11

BAROMETER 730.76 MM HG(28.77 IN HG)          DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)    NOX HUMIDITY CORRECTION FACTOR  1.03
RELATIVE HUMIDITY  73. PCT                   ABS. HUMIDITY 12.3 GM/KG

BAG RESULTS                                    25 SS
  TEST CYCLE

  RUN TIME               SECONDS             900.1
  TOT. BLOWER RATE SCMM (SCFM)             84.81 ( 2994.7)
  TOT. 20X20 RATE SCMM (SCFM)               3.11 (109.8)
  TOT. AUX. SAMPLE RATE SCMM (SCFM)          .05 ( 1.83)
  TOT FLOW STD. CU. METRES(SCF)           1319.8 ( 46600.)

  HC  SAMPLE METER/RANGE/PPM               50.0/21/25.00
  HC  BCKGRD METER/RANGE/PPM               13.8/ 1/ 6.90
  CO  SAMPLE METER/RANGE/PPM               19.6/13/17.74
  CO  BCKGRD METER/RANGE/PPM                 .9/13/  .80
  CO2 SAMPLE METER/RANGE/PCT               76.8/12/.3273
  CO2 BCKGRD METER/RANGE/PCT               11.8/12/.0400
  NOX SAMPLE METER/RANGE/PPM               78.6/ 1/23.37
  NOX BCKGRD METER/RANGE/PPM                 .5/ 1/  .14
  DILUTION FACTOR                             40.42

  HC  CONCENTRATION PPM                       18.27
  CO  CONCENTRATION PPM                       16.45
  CO2 CONCENTRATION PCT                       .2883
  NOX CONCENTRATION PPM                       23.24
  HC  MASS GRAMS                              13.902
  CO  MASS GRAMS                              25.271
  CO2 MASS GRAMS                            6966.49
  NOX MASS GRAMS                              60.422
  MASS OF FUEL BURNED GRAMS                 2226.45
  MEASURED DISTANCE  KM (MILES)            ***** (6.253)
  FUEL ECONOMY  L/100KM (MPG)              27.25 ( 8.632)

  HC   GRAMS/KM (GRAMS/MILE)                1.38 (  2.22)
  CO   GRAMS/KM (GRAMS/MILE)                2.51 (  4.04)
  CO2  GRAMS/KM (GRAMS/MILE)               692.4 (1114.1)
  NOX  GRAMS/KM (GRAMS/MILE)                6.01 (  9.66)

                                           25 SS  COMPOSITE RESULTS
                                                                            PARTICULATE RATE
                HC   GRAMS/KM (GRAMS/MILE)     1.38 ( 2.22)                 GRAMS/TEST       5.175
                CO   GRAMS/KM (GRAMS/MILE)     2.51 (  4.04)                GRAMS/KG FUEL    2.32
                CO2  GRAMS/KM (GRAMS/MILE)   692.40 (1114.07)               GRAMS/KM          .51
                NOX  GRAMS/KM (GRAMS/MILE)     6.01 ( 9.66)                 GRAMS/MILE        .83


                TOTAL DISTANCE  KM (MILES)     ***** ( 6.25)                FILTER EFF.     97.29
                FUEL CONSUMPTION  KG (LB)      2.226 ( 4.909)
                FUEL ECONOMY  L/100KM (MPG)    27.25 ( 8.63)
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TABLE D-39. 25 SS VEHICLE EMISSIONS RESULTS (Cont'd)
PROJECT 03-5428-001

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TEST NO.   1        RUN   1                  VEHICLE NO. 1934                      TEST WEIGHT 13608. KG(30000. LBS)
VEHICLE MODEL 1983 GMC RTSII 04              DATE    12/12/84                      ACTUAL ROAD LOAD  58.4 KW( 78.3 HP)
ENGINE  9.0 L( 552. CID) V-6                 BAG CART NO.  1                       DIESEL     EM-400-F
TRANSMISSION A-3                             DYNO NO.      4                       ODOMETER 223491. KM(138871. MILES)
GVW16738. KG(36900. LBS)                     CVS NO.      11

BAROMETER 730.76 MM HG(28.77 IN HG)          DRY BULB TEMP. 21.7 DEG C(71.0 DEG F)
RELATIVE HUMIDITY  73. PCT                   ABS. HUMIDITY 12.3 GM/KG              NOX HUMIDITY CORRECTION FACTOR  1.03

BAG RESULTS                                      25 SS
   TEST CYCLE

   RUN TIME                 SECONDS             900.1
   TOT. BLOWER RATE SCMM (SCFM)               84.81 ( 2994.7)
   TOT. 20X20 RATE SCMM (SCFM)                 3.11 (109.8)
   TOT. AUX. SAMPLE RATE SCMM (SCFM)            .05 ( 1.83)
   TOT FLOW STD. CU. METRES(SCF)             1319.8 ( 46600.)

   HC  SAMPLE METER/RANGE/PPM                 50.0/21/25.00
   HC  BCKGRD METER/RANGE/PPM                 13.8/ 1/ 6.90
   CO  SAMPLE METER/RANGE/PPM                 19.6/13/17.74
   CO  BCKGRD METER/RANGE/PPM                   .9/13/  .80
   CO2 SAMPLE METER/RANGE/PCT                 76.8/12/.3273
   CO2 BCKGRD METER/RANGE/PCT                 11.8/12/.0400
   NOX SAMPLE METER/RANGE/PPM                 24.4/12/24.37
   NOX BCKGRD METER/RANGE/PPM                   .5/ 1/  .14
   DILUTION FACTOR                               40.42

   HC  CONCENTRATION PPM                        18.27
   CO  CONCENTRATION PPM                        16.45
   CO2 CONCENTRATION PCT                        .2883
   NOX CONCENTRATION PPM                        24.23
   HC  MASS GRAMS                               13.902
   CO  MASS GRAMS                               25.271
   CO2 MASS GRAMS                              6966.49
   NOX MASS GRAMS                               62.997
   MASS OF FUEL BURNED GRAMS                   2226.45
   MEASURED DISTANCE  KM (MILES)             ***** (6.253)
   FUEL ECONOMY  L/100KM (MPG)               27.25 ( 8.632)

   HC   GRAMS/KM (GRAMS/MILE)                  1.38 (  2.22)
   CO   GRAMS/KM (GRAMS/MILE)                  2.51 (  4.04)
   CO2  GRAMS/KM (GRAMS/MILE)                 692.4 (1114.1)
   NOX  GRAMS/KM (GRAMS/MILE)                  6.26 ( 10.07)

                                                 25 SS  COMPOSITE RESULTS
                   HC   GRAMS/KM (GRAMS/MILE)      1.38 ( 2.22)                 PARTICULATE RATE
                   CO   GRAMS/KM (GRAMS/MILE)      2.51 (  4.04)                GRAMS/TEST        5.175
                   CO2  GRAMS/KM (GRAMS/MILE)    692.40 (1114.07)               GRAMS/KG FUEL     2.32
      CONTINUOUS   NOX  GRAMS/KM (GRAMS/MILE)      6.26 (10.07)                 GRAMS/KM           .51
                                                                                GRAMS/MILE         .83

                   TOTAL DISTANCE  KM (MILES)      ***** ( 6.25)                FILTER EFF.     97.29
                   FUEL CONSUMPTION  KG (LB)       2.226 ( 4.909)
                   FUEL ECONOMY  L/100KM (MPG)     27.25 ( 8.63)
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